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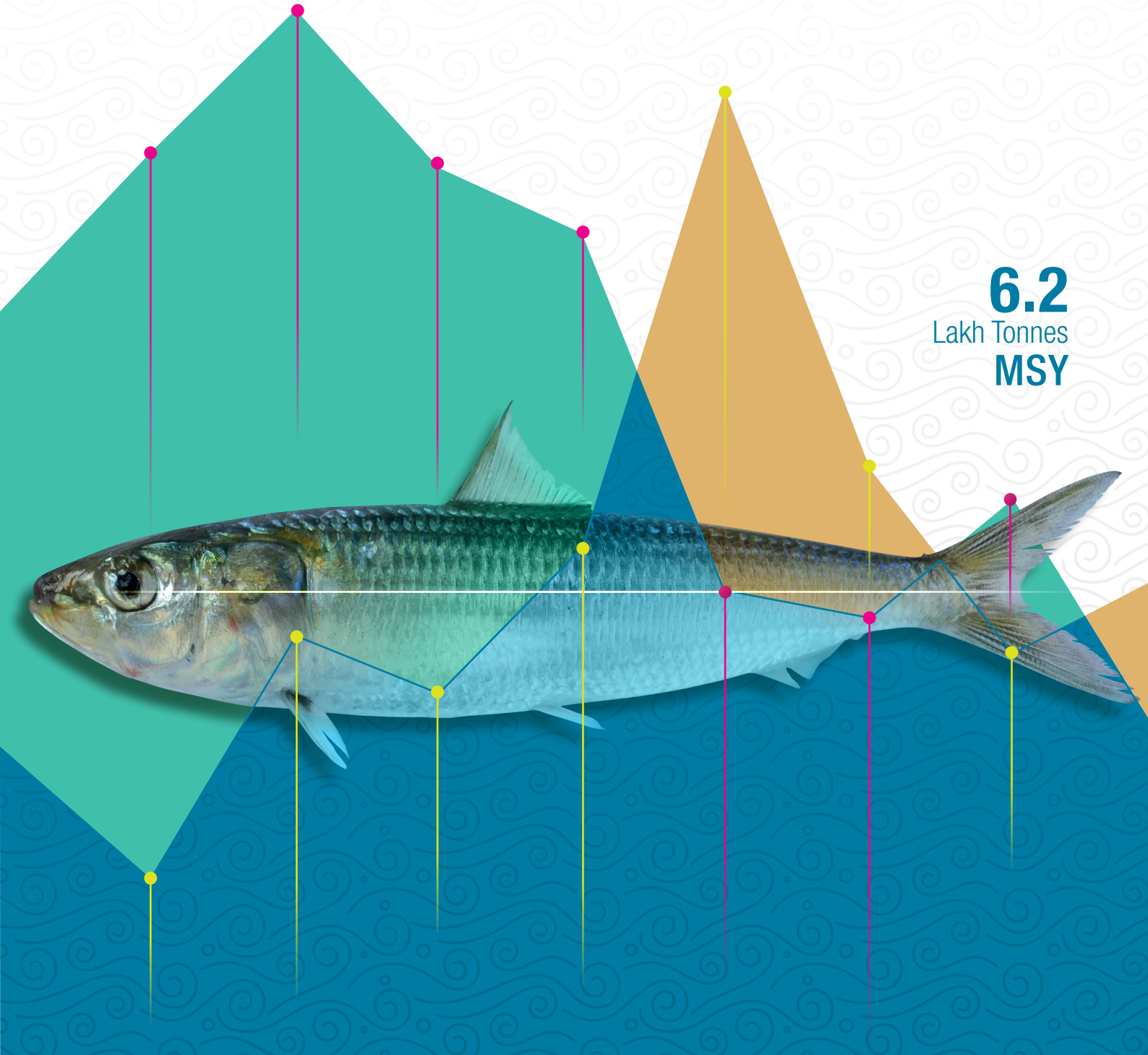
सी एम एफ आर आइ
CMFRI

वार्षिक प्रतिवेदन ANNUAL REPORT
2018-19



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ANNUAL REPORT 2018-19

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ICAR

Indian Council of Agricultural Research

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

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CMFRI Annual Report 2018-2019

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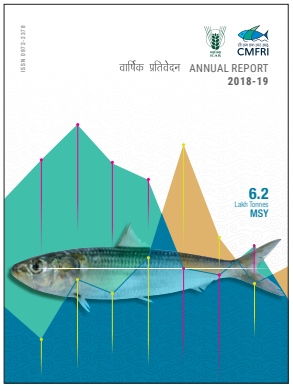

The Indian Oil Sardine (*Sardinella longiceps*), the major single species fishery in India, accounts for about 13% of the total marine fish landing. Cover page depicts the species image super-imposed with its landing trend (red dotted line) in relation to El Niño Southern Oscillation (ENSO) (yellow dotted line).

Citation: CMFRI 2019. Annual Report 2018-19. Central Marine Fisheries Research Institute, Kochi. 320 p

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Mandate

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CMFRI

- Monitor and assess the marine fisheries resources of the Indian Exclusive Economic Zone (EEZ) including the impact of climate and anthropogenic activity and develop sustainable marine fishery management plans
- Basic and strategic research in mariculture to enhance production
- Act as a repository of geospatial information on marine fishery resources and habitats
- Consultancy services and human resource development through training, education and extension

Preface

Greetings !!!

ICAR-Central Marine Fisheries Research Institute (CMFRI), the premier national marine fisheries research Institute, is mandated to assess and advocate advisories for the sustainable harvest, management and conservation of the marine fishery resources of Indian EEZ. The marine fish production has been estimated at 3.49 million tonnes in 2018, recording nearly 9% decrease compared to the previous year. This was primarily due to the steep decline in the production of the Indian oil sardine *Sardinella longiceps* which dropped from 1st to the 9th position, a decline of 54% in the landings at 1.55 lakh tonnes. The Indian mackerel thus, was the major resource and replaced the Indian oil sardine, contributing 2.84 lakh tonnes. Gujarat recorded the first position in total marine fish landings at 7.8 lakhs tonnes followed by Tamil Nadu at 7.00 lakh tonnes and Kerala at 6.43 lakh tonnes.

The Indian oil sardine *Sardinella longiceps* is the most abundant marine fishing resource in the Indian seas. However, this resource is susceptible to wide annual fluctuations and overfishing, spawning failure and environmental and other climatic events. In order to take stock of the current status and to develop a holistic approach to the management of this special fishery, CMFRI collated all the existing data and published information on the Indian oil sardine to come out with a special document "The Enigmatic Oil Sardine: An Insight" which details the probable reasons for fluctuating production trends, changes in distribution ranges, biological responses to oceanographic variables and climatic factors. This will facilitate the better management decisions to conserve and sustain the Oil Sardine fishery.

Another, peer reviewed publication from CMFRI (doi:10.3389/fmars.2018.00443) comprehensively examining the swings in Indian oil sardine catch leading to a `biological catastrophe' (*sic*) not only correlated the environmental fluctuations and climate change influences, but also suggested management measures for the sustenance of the Indian oil sardine fishery.

The resource wise potential yield of marine fishery resources of India, up to 500 m depth for each State and Lakshadweep and Andaman and Nicobar Island Systems has been estimated by a Committee led by CMFRI as 5.31 million tonnes for the coastal States and Island ecosystems of the Indian EEZ.

The marine fish production is subject to climatic impacts and has almost stabilized. In this scenario, CMFRI has been focussing research on mariculture to enhance fish production through sustainable fish farming which will also enhance nutritional security and provide additional livelihood and entrepreneurial opportunities to the coastal communities. In this context, CMFRI has been in the forefront in drafting the National Mariculture Policy (NMP) 2019 which has been submitted Govt. of India for ratification.

The fish farming technologies developed by CMFRI to promote mariculture in Indian waters and augment fish production is slowly paying dividends. The orange spotted grouper, the silver pompano and cobia seed production technologies have been standardized with improved survival rates and fingerlings have been supplied to fish farmers in Kerala, Tamil Nadu, Andhra Pradesh, West Bengal. Successful breeding and seed production of several ornamental fishes (percula clown; tomato clown; skunk clown; maroon clown; percula cross-breds such as picasso platinum; snow flake, ocellaris cross- breds such as black ocellaris and damsels) has been perfected. In order to boost the ornamental fish industry, a National Network Research Project with CMFRI in the lead has been launched with seven collaborating fisheries Institutes

Preface

on ornamental fish breeding and seed production. Green certification of marine ornamental fish has also been initiated.

In order to develop new ingredients as fish feed, experiments on the Black Soldier Fly (BSF) *Hermetia illucens* larval production has been attempted. To further support the mussel farming activities, micro-nursery systems (down welling and upwelling) have been designed and developed for the green mussel seed production in hatcheries. Mussel spat stress tests have been developed for providing guidance to farmers for selecting healthy mussel spat for seeding.

The Institute, through the wide spread outreach programmes, also focuses on the implementation of the management and conservation advisories to protect and conserve the marine fishery resources and diverse ecosystems. In this regard, the policy brief for the sustainable exploitation of the marine Fisheries of Andhra Pradesh has been prepared which outlines 18 recommendations and minimum legal size for 61 species. The Lakshadweep Live Bait Fisheries Management Plan (LLBFMP) has been prepared for sustainable marine fishing resources management of Lakshadweep Islands. The Indian Marine Fisheries Code (IMFC) jointly developed by CMFRI and CIFT has been released. Kerala Marine Fisheries Act 2017, Malayalam version, was developed in association with Kerala State Fisheries Department. Advisory on turtle nesting intensity along the Indian Coast was provided to Seafood Exporters Association of India (SEAI).

A consolidated advisory on the lessons learnt from *Ockhi* cyclone was submitted to Government of Kerala. Sea ranching of 2.5 million seeds of green tiger shrimp *Penaeus semisulcatus* (PL 15-20) was carried out in Palk Bay and Gulf of Mannar to replenish the natural stock and enhance production. CMFRI is also providing assistance to agencies like Directorate of Revenue Intelligence, Govt. of India, by identifying the species of seized shark fin samples and stranded whales. A pamphlet on jelly fishes of Gulf of Mannar and Palk Bay to highlight the jellyfish diversity as well as a first aid jelly safe kit has been prepared for creating awareness.

CMFRI has once again bagged the *Rajarshi Tandon* Award as recognition for official language implementation among Institutes in the 'C' region. The *Rajbasha Gourav Puraskar* 2017-18 was also received by a CMFRI Scientist (Dr. Imelda Joseph) and the Director. Besides these, CMFRI scientists have won national recognitions by receiving ICAR awards – Rafi Ahmed Kidwai Award (Dr. Kajal Chakraborthy), Lal Bahadur Shastri Young Scientist Award (Dr. Eldho Varghese), Jawaharlal Nehru Award for Ph.D. thesis (Anusree V. Nair). Three fisher groups of Tamil Nadu supported by ICAR – CMFRI won the best open sea farming group Award from Tamil Nadu Fisheries Department and was also felicitated at a State Level *Kisan Samriddhi Mela* on 25th of August, organized at the Sugarcane Breeding Institute, Coimbatore at the CODISSIA Trade Fair Complex during 24-26 August 2018.

The fisheries and mariculture research activities are also complemented by basic research such as product development, molecular and genetic investigations. Complete mitogenome of ribbon fish *Trichiurus lepturus* and lobster, *Panulirus polyphagus* have been characterised. Population genetic structure of *Eleutheronema tetradactylum, Lutjanus argentimaculatus* and Scalloped hammer head shark *Sphyrna lewini* have been elucidated and revealed very low level of genetic variation in the Indian waters. Morphological and molecular investigations on Ashtamudi *Paphia malabarica* provided evidence for distinct species status and rejecting its synonymy with *Paphia* (Protapes) *gallus*. The recent assignment of the Ashtamudi clam into the genus *Marcia* and species *Marcia recens* was also proved to be invalid through molecular studies. Anti–hypothyroidism) extract (Cadalmin TM ATe) from seaweed was commercialised to VLCC group. A multi vaccine against vibriosis in cobia was developed and tested on the farmed fishes. The whole genome sequencing of the *Saridinela longiceps* the Indian oil sardine is being carried out (n=48; 1.1 GB) assembling approximately 82% of the genome and it has been found to be comparable to the Japanese sardine and gold-spot sardine.

A high performance computing facility for integrated – modelling, simulation and high end analysis (fish@cmfri) has been established to enhance the quality of fish landings data collection as well as analyses.

CMFRI has a designated marine biodiversity museum and 108 species were deposited this year in the National Repository, including the holotype of a new species of *Conus* and a nematode parasite.

CMFRI's research outputs have been well documented in 284 peer reviewed articles 101 presentations in seminars and symposia 16 technical manuals, 157 book chapters and technical articles, 9 books and 11 videos during the year.

I thank the scientists and all staff of CMFRI for their significant contributions for the development of the fisheries sector and for their continued endeavours to excel.

Executive Summary

CMFRI had 37 in-house research projects, 34 externally funded projects and 12 consultancy projects in operation in the year 2018-19.

Total marine fish landings along the coast of mainland of India for the year 2018 is estimated at 3.49 million tonnes showing a decline of about 3.47 lakh tonnes (9%) compared to 3.83 million tonnes in 2107. Among the nine maritime states Gujarat remained in the first position with landings of 7.80 lakh tonnes followed by Tamil Nadu with 7.02 lakh tonnes. Indian oil sardine, the topmost contributor to the Indian marine fish basket recorded the sharpest fall of 54%, plummeting to ninth position from its first position in 2017. Indian mackerel became the topmost resource with a contribution on 2.84 lakh tonnes towards the total landings (8.1%). Sustained bumper landings of red toothed triggerfish (*Odonus niger*) were observed in the west coast since August 2018. There was considerable reduction in the number of fishing days in West Bengal, Odisha, Andhra Pradesh, Tamil Nadu and Puducherry due to cyclonic storms *Titli, Gaja* and *Phethai*.

The assemblage wise marine fish landings of Gujarat for the year 2018 showed the predominance of

molluscan resources (7%). Pelagic finfish resources (38%), followed by demersal (30%), crustaceans (25%) and molluscan resources (7%). The marine fish landings in Maharashtra during 2018 was 2.95 lakh t with 22.5% decrease from previous year (3.81 lakh t in 2017). The prominent species/groups that contributed to the fishery of the state were non-penaeid shrimps (12.6%), penaeid shrimps (11.4%), croakers (10.2%), threadfin breams (8.4%), Indian mackerel (7.1%), Bombay duck (5.6%) and squids (5.2%). Marine fish landings in Kerala during 2018 were 6.42 lakh t which was 9.8% higher than that of the previous year (2017). The major resources in the catch was Indian mackerel (12.6%) followed by oil sardine (12%), threadfin breams (8.3%), *Stolephorus* (8%) and penaeid shrimps (7.9%).

Pelagic finfishes dominated the landings with a share of 62%, which was 6.1% higher than that of the previous year's estimated pelagic catch. The total marine landing in Tamil Nadu in 2018 was 7.02 lakh t showing an increase of 7% when compared to previous year. Pelagic finfishes formed 52.1%, demersal fin fishes 33%, crustaceans and cephalopod 7.5% each. The total landing in Puducherry was 45406 t showing an increase of 68% when compared to previous year. Pelagic resources formed 30.5%, demersal 27.2%, crustaceans 17.7% and cephalopods 22.2%. Marine landings of Andhra Pradesh were 1.92 lakh t in 2018. There was a decline of 3.6% in marine landings of the state from 2018 to 2017. The marine landings of the state have been in constant decline since the peak landings of 2014. Pelagic fishes were the dominant resource followed by demersal, crustaceans and molluscans. Lesser sardines dominated by weight accounting for 17.8% of the total fish landed. Among pelagics, major resources landed were clupeids (47.7%), mackerel (13.84%), carangids (12.4%), ribbonfish (7.25%), tunas (6.3%) and seerfish (3.15%). Barracuda and billfish contributed 2.49% and 1.6%, respectively. The major demersal resources were croakers (17.8%), other perches (10.2%), goatfish (9.9%), threadfin breams (8.9%) and catfish (8.6%). Crustacean landing was contributed by penaeid shrimps (68.9%), non-penaeid shrimps (2.8%), crabs (27.4%), lobsters (0.2%) and stomatopods (0.7%). The major molluscan resources were the cephalopods which comprised of the cuttlefishes (76.44%) and squids (23.56%). West Bengal during 2018 was 1.6 lakh t which decreased by about 56% compared to the previous year (3.6 lakh t). The total marine landings of Odisha coast during 2018 was estimated at 89178 t registering a decline of about 30% compared to the previous year (126958 t).

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Large pelagic fish landing during 2018 was only 249,876 t by registering an improvement of about 22% over the previous landing. Major share of the landing was constituted by tunas, followed by barracudas, seerfishes and billfishes. Among the maritime states Tamil Nadu is the major contributor, followed by Kerala, Gujarat and Karnataka.

Elasmobranch landings in India during 2018 was 42,117 t, increasing marginally by 2% from the previous year. Tamil Nadu and Gujarat were the major contributors. The west coast accounted for 50.5% of the landings and the east coast, 49.5%. Tamil Nadu, Puducherry, Gujarat and Daman and Diu together accounted for 68.4% of the total elasmobranch landings in the country.

Bivalve production in 2018 in the country was estimated at 1,32,531 tonnes. The fishery was dominated by clams, consisting of 76.3%, followed by mussels, 15.3% and oysters, 8.4%. Clams dominated the fishery contributing 76.3% to the annual bivalve production followed by mussels, 15.3% and oysters, 8.4%. Gastropod fisheries assessment and developments in shell craft industry was also a part of the molluscan research.

Regular stakeholder consultations were conducted both at Headquarters and Centres of CMFRI so that research results reach them on time and future research is planned with their inputs. Continuing the genetics and genomics research, the complete mitogeneome of ribbon fish was characterized and the whole genome of the Indian oil sardine is being characterized. Population genetics structure of hammer head sharks when studied called for effective conservation measures. Forensic identification services for sharks and whales is also provided. CMFRI through its studies proved the invalidity of renaming *Paphia malabarica* and its reassignment to the genera *Marcia* in absence of molecular evidence. Genetic divergence in broodstock of cobia, characterization of stress genes in *Etroplus* and complete characterization of the mitogenome of spiny lobster *Panilurus polyphagus* are other activities taken up. Population genetic structure of Indian salmon *Eluthronema tetradactylum* and stock structure of *Lutjanus argentimaculatus* was elucidated. Growth and growth related gene expression in Indian pompano in another aspect studied. Studies on biomineralization of mantle tissue in *in-vitro* pearl culture and charecterization of embryonic stem cells by karyotyping are the works carried out in the area of cell and tissue culture. eDNA is another frontier area of work pursued.

In the area of fish nutrition and feed technology, CMFRI's *Varsha* series of freshwater ornamental fish feeds were trialled in commercial extruders and refined for commercial production. *Varna* series of marine ornamental production and sale at the Institute touched an all-time high. Our work on insect protein production gained momentum. Green bottle fly when grown on fish waste, its pupae meal contained DHA and EPA. We found fish meal can be replaced with cotton seed meal in feeds for pompano. *Heterochlamydomonas lobate* a new alga, rich in red pigments was isolated from Gulf of Mannar. Nutritional evaluation of chlorophytan seaweeds was done. Nutritional profiling of a couple of deep-sea shrimp was also completed. Development of a fish waste bacterial consortium is in progress. Probiotic bacterial strains are regularly screened for application in fish nutrition. And, a sieve shaker was developed in-house at a tenth of the cost at which it is available in the market.

In the area of fish health management, myxosporean infections were documented. Lepas and egg predator worms were reported from the berried lobsters in Chennai. *Perkinsus olseni* and *P. behaiensis* were recorded in bivalves. Mass awareness programmes were conducted to highlight the management practices to be adopted by the mussel farmers. *Vibrio vulnificus* infection was reported in farmed tilapia (GIFT). There was a resurgence of epizootic ulcerative syndrome (EUS) after the floods in 2018. In-depth studies on bacterial infections in cobia and pompano were continued. Neoplasia in cobia is another unique finding. Serum protein was established as the best ecotype specific health index in snappers. Mass immunization trials against vibriosis in cobia progressed successfully. Development of "Perkdetect", a LAMP based diagnostic against *Perkinsus* infections in bivalves is another noteworthy development.

Through marine bioprospecting, a nutraceutical to combat hypothyroid dysfunctionalities: Cadalmin™ Anti-hypothyroidism extract (Cadalmin™ ATe) was developed and released. Seaweed-associated *Firmucutes* and *Gammaproteobacteria* as prospective anti-infective agents against multidrug resistant pathogens were isolated and studied. Two halogen derivatives, characterized as 2-butyl-7-4-(chloromethyl) cyclooct-1-enyl) hept-5-en-1-ol (1) and 4-(2-chloroethyl)-5-7-(methoxymethyl) undec-3-enyl) cyclooct-4-enone (2) were isolated from the organic extract of the seaweed, *Kappaphycus alvarezii*. This happens to be the first report on the structural characterization of unusual halogen analogues from *K. alvarezii* with dual cyclooxygenase-2 and 5-lipoxygenase inhibitory activities. Characterisation of two spiro[5.5]undecanes (1 and 2)

with anti-inflammatory properties, from *Gracilaria* and *Salicornia* was another area of work. Marine microalgae as valuable natural sources of bioactive compounds with antihypertensive activities are also explored.

Continuing breeding and seed production of cobia and pompano, a total of 28,200 cobia fingerlings were produced and about 10,600 fingerlings were supplied to farmers and research institutions for farming, field demonstrations and broodstock development. About 17,600 fingerlings are being reared for supplying to farmers to carry out demonstrations on open sea cage farming. Two lakh sixty thousand silver pompano fingerlings were produced and supplied to farmers, fishermen and research institutions of Karnataka, Kerala, Tamil Nadu, Pondicherry, Andhra Pradesh and West Bengal for farming and field demonstrations. About 30,000 fingerlings were used for conducting research experiments at CMFRI Centre's. Breeding and seed production of orange spotted grouper *Epinephelus coioides* at Visakhapatnam continued with a larval survival rate of 12%. A total of 3.3 million shrimp post larvae (*Penaus smisulcatus*) were sea ranched in Gulf of Mannar and Palk Bay. At Chennai, three batches of sand lobster *Thenus unimaculatus* larvae were reared to final settlement level. Seed production of commercially important marine ornamental fishes viz., *Amphiprion percula, A. ocellaris, Amphiprion frenatus* and *Amphiprion sandaracinos* (Orange skunk clown) are being done at various CMFRI centres. Seed production and scaling up of the hybrid clown fish varieties viz., Platinum, Snow flake and Picasso clown are in progress at Mandapam Regional Centre. Revenue generation was to the tune of Rs. 2.297 lakhs through the sale of marine ornamental fish. In the area of live feed culture, a consolidation of biological details and culture protocols of all nine species of copepods has been published in the form of a book on "Culture techniques of marine copepods" by CMFRI.

Cage culture of orange spotted grouper was done in HDPE cages at Visakhapatnam coast. After a culture period of 15 months the fishes reached a size of 2 kg. In a capture based culture of golden trevally along with snappers and seabass the harvested fishes reached 500 to 600 g in 160 days of culture. Culture demonstration of seabass was conducted at Perinjanamin Kerala, Nagnathwada and Small Masjid, traditional fishing villages in Karwar and Mandapam, Sippikilam and Keelavaipar in Tamil Nadu. Intersex in Cobia (*Rachycentron canadum*), a gonochoristic species, was recorded in a fish cultured in sea cages at Mandapam Regional Centre of CMFRI. Post stunting, compensatory growth was found in experiments with pompano. In bivalve mariculture, eco-friendly mussel farming strategies were popularized and the CMFRI advisory on mussel farming practices advocated were adopted and a Govt. of Kerala notification was brought out.

In the field of marine biodiversity, development of conservation plans for biologically sensitive areas along the Indian coast was done Kerala, Karnataka, Andhra Pradesh and Tamil Nadu. Diversity and taxonomy of Jellyfishes was monitored along the India coast. JellySafe first aid kit was released on the occasion of 72nd Foundation day at Mandapam Regional Centre of CMFRI on 5th February 2018. A preliminary survey of Coral reef sites was carried out in the Andaman Islands during 5-11 October 2018. Two sites in Havelock Island, Elephant Beach and Havelock and one site in Wandoor in Port Blair were surveyed and documented through underwater photography and videography. High degree of coral species diversity along with coral reef fishes, sea urchins, holothurians, gastropods and giant clams were recorded. PCR amplification and sequencing of 45 individuals from 15 species of the families Conidae and Strombidae for four genes have been completed. CDRRP-FIMSUL II (Tamil Nadu Fisheries Department) Estimation of marine fish landings in Tamil Nadu with enhanced sampling coverage, a mobile app namely *ËNMEEN* was developed to facilitate on line data collection and data transmission. A total of 63 species of avian fauna were recorded from the Kadalundi-Vallikunnu Community Reserve. Of these, 40 are resident species and the rest migratory. Taxonomical Investigation on lesser Known marine animals of India-Phylum: Cnidaria (Class: Anthozoa) and Phylum: Porifera (Marine) Survey and inventorisation of sponge resources was also done.

While investigating the marine macrophytes in India, resource dynamics and ecosystem services, production from farming of seaweed *Kappaphycus alvarezii* along south east coast of India during 2018 was estimated as 350 tonnes dry weight, about five times higher than previous year. *Nannochloropsis* sp was found to have best phytoremediation potential as well as growth followed by *Isochrysis* sp. and *Chaetoceros* sp among the three microalgae studied. Assessment of coastal marine pollution continued. Micro-level environmental management plans (EMP) for selected critical habitats for ecosystem health and sustainable production lead to development of a community based participatory model protocol for micro level EMP for

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reducing litter accumulation in water bodies. A practical method to collect and remove household plastic waste was developed through a participatory village level program and it is estimated that about 345 tonnes of plastic can be effectively managed if this protocol. Spatial Database on turtle nesting intensity along Indian coast was used to analyse the pattern of turtle nesting along the Indian coast using ArcGIS 10.0 software. An interactive map of baleen whale stranding locations has been developed and has been hosted in the Institute website. The state of maturation of artificial reefs deployed at selected sites along north Tamil Nadu coast were assessed and the impact of the artificial reefs on habitat, biodiversity, resource abundance, fishery and socioeconomic implications was studied.

In the National Innovations on Climate Resilient Agriculture (NICRA) project under phenology and distribution, prevalence of disease in demersal fishes in relation to rise in sea bottom temperature, in fishes belonging to the family Lutjanidae and Priacanthidae revealed that, the parasitic infestations disrupted the ovarian lamellar walls, causing atrophy and are philometrid nematods belonging to the superfamily Dracunculoidea Stiles, 1907. The carbon assimilation potential of 8,445 tonnes of commercially important seaweed biomass along Gulf of Mannar was estimated as 450.3 tonnes CO_2/day against 14.5 tonnes of CO_2 emitted/day. A MoU was signed between ICAR-CMFRI, Kochi and Space Applications Centre (ISRO), Ahmedabad on 8th April 2019 at SAC campus with focus to develop a centralized web portal and mobile application for integration of field level regional wetland data with geospatial dataset so as to enable real-time wetland advisories. A multivendor e-commerce website and associated mobile app was developed for enabling direct sales and marketing between fishers and customers, which was released by Hon. DG, ICAR on 7th December 2018 at NASC, New Delhi. An impact assessment of Kerala Flood 2018 on the hydrology of Ashtamudi and Vembanad Lakes and intertidal regions were also carried out.

Valuation of marine fish landings, researched under the economic performance and supply chain management was Rs. 52,636 crores, (0.39% increase over 2017). The valuation of Indian fisheries *vis-à-vis* landings – major species was also done. At the national level (macro level) the total operating cost was estimated at Rs.28,950 crores and the net operating income at Rs.23,686 crores. The average capital productivity worked out to 0.55 and the gross value added to the marine fisheries sector was estimated at Rs.35,266 crores. Economic performance of marine fishing methods was also assessed. Documenting price behaviour of marine fish varieties, the average landing centre price for major species ranged from Rs.90.13 per kg for oil sardines to Rs.309.32 per kg for penaeid shrimp, closely followed by non-penaeid shrimp at Rs.174.15 per kg. The analysis of marine fish marketing efficiency across the different states in India indicated that Kerala registered the highest share of consumer rupee at 72.33 percent and Odisha the lowest at 58.13 percent. The higher market efficiency indicates that the fishers receive higher share of the consumers' price and also the number of intermediaries in this market channel are less. Results of the studies across the selected coastal states-Kerala, Odisha, Andhra Pradesh, West Bengal and Gujarat (360 respondents) indicated that socio economic variables significantly influenced the fish consumption pattern. Reflections of economic recession on Indian seafood exports, amidst the global recession and economic meltdown indicated that the exports were augmented. The E-Marketing Intervention in Indian fisheries sector funded by the National Fisheries Development Board (NFDB) aimed at the development of a fish market information system (FMIS) has been initiated and a field manual on commercially traded fishes of India was finalized with 150 marine and inland fish species was developed.

In the area of fisheries governance, livelihood and gender welfare, impact of the Kerala Marine Fishing Regulation (Amendment) Bill, 2017 has been patterned by analysing the average number of the impounding reported before and after its existence. It was found that the traditional quasi credit, inter-linked market-tying deals between auctioneers and fishermen, still continue to be a dominant mode of informal lending. The sustainability of *Theeramythri* enterprises were determined using benefit monitoring and evaluation matrices which include asset ratio, wage rates realised and average employment days across the different districts and sectors. Gender mainstreaming in marine fisheries sector, assessed the level of performance and extent of empowerment of through appropriate indices of measurement from Kerala, Tamil Nadu, Andhra Pradesh and Odisha.

Technology advisory services were provided to 13,600 visitors in the institute, 1050 people through telephonic contacts/ emails and another 8,000 people through exhibitions as well as training programmes during 2018-19. The annual revenue generated during 2018-19 through sale of institute technology products and visitor's fee collection was Rs.5.78 lakhs.

कार्यकारी सारांश

सी एम एफ आर आइ में वर्ष 2018-19 के दौरान 37 गृहांदर परियोजनाएं 34 बाह्य वित्त पोषित परियोजनाएं तथा 12 परामर्श योजनाएं संचालित की गयी थीं.

वर्ष 2018 के दौरान भारत की मुख्य भूमि के तट पर कुल 3.49 टन का समुद्री मछली अवतरण आकलित किया गया जिसमें वर्ष 2017 के 3.83 मिलियन टन की तुलना में 3.47 (9%) लाख टन की कमी पायी गयी। मछली अवतरण में नौ समुद्रवर्ती राज्यों के बीच गुजरात 7.80 लाख टन के साथ प्रथम स्थान पर रहा जिसके बाद 7.02 लाख टन के साथ तमिलनाडु था। भारतीय समुद्री मछली बाज़ार में ज़्यादा योगदान देनेवाली भारतीय तारली के अवतरण में 54% की घटती पायी गयी जिसकी वजह से वर्ष 2017 के प्रथम स्थान से नौवें स्थान तक की गिरावट महसूस की गयी। कुल अवतरण (8.1%) में 2.84 लाख टन के योगदान सहित भारतीय बांगडा सबसे अधिक पायी गयी। अगस्त 2018 से पश्चिम तट पर रेड टूथड ट्रिगर फिश (ओडोनस नीगर) का टिकाऊ भारी अवतरण पाया गया। पश्चिम बंगाल, ओडीषा, आंध्र प्रदेश, तमिलनाडु एवं पुतुच्चेरी में तितली, गजा, फीतई जैसे चक्रवातों के कारण मत्स्यन दिनों की संख्या में काफी कमी हुई थी।

वर्ष 2018 के दौरान गुजरात के संपदावार मछली अवतरण में मोलस्कन संपदाओं (7%) की प्रचुरता देखी गयी। अवतरण में वेलापवर्ती पखमछली संपदाएं (38%) थीं, जिसके बाद तलमज्जी (30%), क्रस्टेशियन (25%) एवं मोलस्कन संपदाएं (7%) थीं। वर्ष 2018 के दौरान महाराष्ट्र में समुद्री मछली अवतरण 2.95 लाख टन था, जो पिछले वर्ष (2017 में 3.81 लाख टन) की तुलना में 22.5% कम था। राज्य की मात्स्यिकी में योगदान देनेवाली प्रमुख प्रजातियां / ग्रुप नोन-पेनिआइड चिंगट (12.6%) पेनिआइड चिंगट (11.4%), क्राकेर्स (10.2%), सूत्रपख ब्रीम (8.4%), भारतीय बांगडा (7.1%), बम्बिल (5.6%) और स्क्विड (5.2%) थे। वर्ष 2018 के दौरान केरल का समुद्री मछली अवतरण 6.42 लाख टन था जो, पिछले वर्ष (2017) की तुलना में 9.8% ज़्यादा था. पकड़ में प्रमुख संपदाएं भारतीय बांगडा (12.6%) थी जिसके बाद तारली (12%), सूत्रपख ब्रीम (8.3%), स्टोलिफोरस (8%) एवं पेनिआइड चिंगट (7.9%) थीं। वेलापवर्ती पख मछली का अवतरण 62% था, जो पिछले वर्ष आकलित वेलापवर्ती पकड़ की तुलना में 6.1% ज़्यादा था. वर्ष 2018 में तमिलनाडु का कुल मछली अवतरण 7.02 लाख टन था, जिस में पिछले वर्ष की तुलना में 7% की वृद्धि पायी गयी। अवतरण का 52.1% वेलापवर्ती पखमछलियां, 33% तलमज्जी पखमछलियां, 7.5% क्रस्टेशियन एवं शीर्षपाद था। पुतुच्चेरी में आकलित कुल अवतरण 45406 टन था, जिस में पिछले वर्ष की तुलना में 68% की वृद्धि पायी गयी। अवतरण में, 30.5% वेलापवर्ती सम्पदाएं, 27.2% तलमज्जी, 17.7% क्रस्टेशियन, 22.2% शीर्षपाद सम्मिलित थीं। वर्ष 2018 में आन्ध्रा प्रदेश का समुद्री मछली अवतरण 1.92 लाख टन आकलित किया गया था। 2018 से 2017 तक राज्य के कुल मछली अवतरण में 3.6% की घटती पायी गयी। वर्ष 2014 के भारी अवतरण के बाद राज्य के समुद्री मछली अवतरण में लगातार गिरावट पायी गयी। वेलापवर्ती मछलियाँ प्रमुख संपदाएं थी, जिसके बाद तलमज्जी, क्रस्टेशियन एवं मोलस्कन संपदाएं थीं। अवतरण की गयी कुल मछलियों में 17.8% वज़न के अनुसार लेस्सर सारडीन थी। वेलापवर्ती में, अवतरण की गयी प्रमुख संपदाएं क्लूपिड (47.7%), बांगड़ा (13.84%), करांजिड (12.4%) फीतामीन (7.25%) ट्यूना (6.3%) एवं सुरमई (3.15%) थीं। बराकुडा एवं बिल फिश ने क्रमशः 2.49% और 1.6% का योगदान दिया। क्रोकर्स(17.8%), अन्य पर्च (10.2%), गोट फिश (9.9%), सूत्रपख ब्रीम (8.9%) एवं शिंगटी (8.6%) प्रमुख तलमज्जी संपदाएं थीं। क्रस्टेशियन अवतरण में पेनिआइड चिंगट (68.9%), नोन-पेनिआइड चिंगट (2.8%), केकड़ा (27.4%), महाचिंगट (0.2%) और स्टोमेटोपोड (0.7%) का योगदान प्रमुख था। मोलस्कन संपदाओं में प्रमुख शीर्षपाद थे, जिनका मुख्य भाग कटलफिश (76.44%) और स्क्विड (23.56%) था। वर्ष 2018 के दौरान पश्चिम बंगाल का कुल मछली अवतरण 1.6 लाख टन था, जिसमें पिछले वर्ष (3.6 लाख टन) की तुलना में 56% की घटती पायी गयी। वर्ष के दौरान 2018 ओडीषा तट का कुल मछली अवतरण 89178 टन आकलित किया गया, जिसमें पिछले वर्ष (126958 टन) की तुलना में 30% की घटती पायी गयी.

Executive Summary

वर्ष 2018 के दौरान केवल 249,876 टन बड़ी वेलापवर्ती मछलियों का अवतरण किया गया था, जिसमें पिछले वर्ष के अवतरण से 22% का वर्धन था। अवतरण में सबसे प्रमुख ट्यूना थी, जिसके बाद बराकुडा, सुरमई और बिल फिश थी। समुद्रवर्ती राज्यों में प्रमुख योगदान तमिल नाडु का था, जिसके बाद केरल, गुजरात और कर्नाटक रहे।

वर्ष 2018 के दौरान उपास्थिमीनों का अवतरण 42,117 टन था, जिसमें पिछले वर्ष से 2% की सीमांत वृद्धि देखी गयी। तमिल नाडु और गुजरात का सबसे ज्यादा योगदान हुआ। अवतरण में पश्चिम तट का योगदान 50.5% और पूर्व तट का49.5% था। राज्य के कुल उपास्थिमीन अवतरण में तमिलनाडु, पुतुच्चेरी, गुजरात एवं दामन और दिउ का योगदान 68.4% था.

वर्ष 2018 में राज्य का द्विकपाटी उत्पादन 1,32,531 टन आकलित किया गया. मात्स्यिकी में 76.3% सहित सीपियाँ ज़्यादा थीं जिसके बाद शंबुएं 15.3% और शुक्तियां 8.4% थे. वार्षिक द्विकपाटी उत्पादन में 76.3% सहित सीपियों का योगदान ज़्यादा था जिसके बाद शंबुएं 15.3%और शुक्तियां 8.4% थे. शेल क्राफ्ट उद्योग में गास्ट्रोपोड मात्स्यिकी निर्धारण एवं विकास भी मोलस्कन अनुसंधान के अंतर्गत आता है.

सी एम एफ आर आइ मुख्यालय और अधीनस्थ केन्द्रों में नियमित हितधारक विचार - विमर्श का आयोजन किया गया ताकि समय पर अनुसंधान परिणाम उन तक पहुंचे जा सके और इसके अनुसार भविष्य की अनुसंधान योजना बनायी जा सकी। आनुवंशिकी एवं जीनोमिक्स अनुसंधान को बनाए रखते हुए, फीतामीन के पूरा माइटोजीनोम का विशेषीकरण किया गया और भारतीय तारली के पूरे जीनोम का विशेषीकरण किया जा रहा है. हैमर हेड शार्क की जीव संख्या आनुवंशिक संरचना पर अध्ययन किए जाने पर प्रभावी परिरक्षण उपायों के लिए सुझाव दिया गया। शार्क एवं सुराओं की फोरेंसिक पहचान सुविधाएं भी प्रदान की गयीं। सी एम एफ आर आइ अपने अध्ययन के ज़रिए पाफिया मलबारिका की अवैधता और आण्विक साक्ष्य के अभाव के कारण मार्सिया वंश से इसका पुनर्निर्धारण साबित किया। अन्य गतिविधियों में कोबिया के ब्रूडस्टॉक में आनुवंशिक अंतर, एट्रोप्लस में स्ट्रेस जीन का विशेषीकरण, शूली महाचिंगट पानिलूरस पोलीफागस के माइटोजीनोम का पूरा विशेषीकरण सम्मिलित हैं। भारतीय सालमन एलुत्रोनेमाटेट्राडकटैलम की जीव संख्या आनुवंशिक संरचना एवं लूटजानस अरजेंटिमाकुलेटस की प्रभव संरचना की व्याख्या दी गयी। भारतीय पोम्पानो की वृद्धि एवं इससे संबंधित जीन पर अध्ययन किया गया। कोशिका एवं ऊतक संवर्धन के क्षेत्र के कार्यों में, पात्रेन मोती उत्पादन में प्रावार ऊतक का बायोमिनेरेलैज़ेशन एवं करोटैपिंग के ज़रिए अपरिपक्व कोशिकाओं के विशेषीकरण पर अध्ययन प्रमुख हैं। अन्य मुख्य क्षेत्र eDNA से संबंधित है।

मछली पोषण एवं खाद्य प्रौद्योगिकी के क्षेत्र में, सी एम एफ आर आइ के मीठा पानी अलंकारी मछली खाद्य वर्षा श्रेणी वाणिज्यिक रूप से उत्पादन के लिए तैयार की गयी है। संस्थान में वर्णा का उत्पादन एवं विपणन सर्वाधिक स्तर पर है। कीट प्रोटीन उत्पादन पर हमारे काम में और अधिक गति प्राप्त की गयी। मछली अपशिष्ट में बढ़ने वाली ग्रीन बोटिल मक्खी के प्यूपे में डी एच ए एवं ई पी ए निहित है। यह देखा गया कि पोम्पानो मछली को दिए जाने वाल मछली खाद्य के बजाय कोटन सीड से बने खाद्य दिया जा सकता है। मन्नार खाड़ी से रेड पिगमेंन्ट से संपुष्ट हेटेरोक्लामैडोमोनस लोबेटे नामक शैवाल को पृथक किया गया। क्लोरोफैटन समुद्री शैवालों की पौष्टिकता का मूल्यांकन किया गया। गहरे समुद्र चिंगट के जोड़े की पोषण संबंधी रूपरेखा भी पूरी हो गयी। मछली अपशिष्ट जीवाणु संघ का विकास प्रगति पर है। प्रोबयोटिक जीवाणु प्रभेदों को मछली पोषण में अनुप्रयोग करने के लिए नियमित रूप से जांच की जाती है। संस्थान में छलनी शेकर का विकास किया गया, जो बाज़ार में उपलब्ध लागत के दसवें हिस्से पर प्राप्य है।

मछली स्वास्थ्य प्रबंधन में, मिक्सोस्पोरेन संक्रमणों का प्रलेखन किया गया। चेन्नई में, अंडयुक्त महाचिंगटों में लेपास एवं अंडा शिकारी कीटों की रिपोर्ट की गयी। द्विक्पाटियों में पेरकिन्सस ओल्सेनी एवं पी. बेबहाएन्सिस का आकलन किया गया। शुक्ति पालनकारों द्वारा अपनाए जानेवाले प्रबंधन तरीकों पर प्रकाश डालने के लिए व्यापक तौर पर जागरूकता कार्यक्रम आयोजित किए गए। पालन की गयी तिलापिया (जी आइ एफ टी) मछली में विब्रियो वल्निफिकस संक्रमण की रिपोर्ट की गयी। वर्ष 2018 की बाढ़ के बाद एपिज़ूटिक अलसेरेटीव सिंड्रोम (ई यु एस) का पुनरुत्थान देखा गया। कोबिया एवं पोम्पानो के जीवाणु संक्रमण पर गहरा अध्ययन किया गया। कोबिया में नियोप्लासिया अन्य अनोखी खोज है। स्नाप्पर मछली में सबसे अच्छा इकोटाइप विशिष्ट स्वास्थ्य सूचकांक के रूप में सेरम प्रोटीन को स्थापित किया गया। कोबिया में विब्रियोसिस के विरुद्ध बड़े पैमाने पर किए गए प्रतिरक्षण परीक्षणों में सफलतापूर्वक प्रगति पायी गयी। द्विकपाटियों में पेर्किन्सस संक्रमण के विरुद्ध एल ए एम पी पर आधारित "पर्कडक्ट" का विकास अन्य उल्लेखनीय विकास है।

समुद्री जैवपूर्वेक्षण के द्वारा, हाइपोथाइरोइड अवुविधाओं के उपचार के लिए Cadalmin™ एंटी- हाइपोथाइरोइडिसम एक्स्ट्रेक्ट (Cadalmin™ ATe) विकसित करके विमोचन किया गया। मल्टी-ड्रग प्रतिरोधी रोगजनकों के प्रति प्रत्याशी संक्रामक विरुद्ध ऐजेन्टों के रूप में समुद्री शैवाल से जुड़े हुए फर्मुक्यूट्स और गामाप्रोटियोबैक्टीरिया का विलगन करके अध्ययन किया गया। समुद्री शैवाल कापाफाइकस अल्वरेज़ी के जैविक सार से 2-butyl-7-4-(chloromethyl) cyclooct-1-enyl) hept-5-en-1-ol (1) और 4-(2-chloroethyl)-5-7-(methoxymethyl) undec-3-enyl) cyclooct-4-enone (2 के रूप में विशेषित दो हेलोजन व्युत्पन्नों का विलगन किया गया। यह डुअल साइक्लोओक्सीजनेस-2 और 5-लिपोक्सीजनेस निरोधात्मक गतिविधियाँ सहित के.अल्वरेज़ी के असामान्य हेलोजन अनुरूपों के संरचनात्मक लक्षण वर्णन पर पहली रिपोर्ट है। ग्रेसिलेरिया और सालिकोर्निया से प्रति-सूजन गुणों से युक्त

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दो spiro[5.5]undecanes (1 and 2) का विशेषीकरण इस क्षेत्र का एक और काम है। एंटीहाइपरटेंसिव गतिविधियों के साथ जैवसक्रिय यौगिकों के मूल्यवान प्राकृतिक स्रोतों के रूप में समुद्री सूक्ष्म शैवाल का भी पता लगाया जाता है।

कोबिया एवं पोम्पानो के प्रजनन एवं संतति उत्पादन के सम्बन्ध में, कुल 28,200 कोबिया संततियों का उत्पादन किया गया और 10,600 संततियों को कृषकों एवं अनुसंधान संस्थानों में पालन, क्षेत्र प्रदर्शन एवं ब्रूडस्टाक विकास के लिए प्रदान किया गया. करीब 17,600 संततियों को पालन करके खुला समुद्र पिंजरा मछली पालन के लिए कृषकों को प्रदान किया जाता है. दो लाख साठ हज़ार सिल्वर पोम्पानो संततियों का उत्पादन करके कर्नाटक, केरल, तमिलनाडु, पुतुच्चेरी, आंध्र प्रदेश एवं पश्चिम बंगाल के कृषकों, मछुआरों एवं अनुसंधान संस्थानों में पालन एवं क्षेत्र प्रदर्शन के लिए प्रदान किया गया. करीब 30,000 संततियों को सी एम आफ आर आइ के केन्द्रों में अनुसंधान परीक्षण के लिए उपयोग किया गया.

विशाखपट्टणम में नारंगी चित्ती ग्रूपर एपिनेफेलुस्कोइओडिस का प्रजनन एवं संतति उत्पादन 12% की डिम्भक अतिजीविता दर सहित बनाया रखा. मन्नार खाड़ी और पाक खाड़ी में चिंगट के कुल 3.3 मिलियन पश्च डिंभकों (shrimp post larvae) (पेनौमिसुलकेटस) का समुद्री रैन्चन किया गया. चेन्नई में, रेती महाचिंगट थीनस माकुलेटस के डिम्भकों के तीन बैचों का पालन किया गया. सी एम एफ आर आइ के विविध केन्द्रों में वाणिज्यिक प्रमुख अलंकारी मछलियां जैसे कि आम्फीप्रियोन पेर्कुला, ए. ओसेल्लारिस,आम्फीप्रियोन फ्रेनेटस एवं आम्फीप्रियोन सांडारासिनोस (ओरंज स्कंक क्लाउन) का संतति उत्पादन किया जा रहा है। मंडपम क्षेत्रीय केंद्र में हाइब्रिड क्लाउन मछली के विविध प्रकार जैसे कि प्लाटिनम, स्नो फ्लेक एवं पिक्कासो के संतति उत्पादन एवं वृद्धि प्रगति में है. समुद्री अलंकारी मछली उत्पादन से 2.297 लाख रु का आय प्राप्त हुआ. जीव खाद्य संवर्धन के क्षेत्र में सी एम एफ आर आइ द्वारा नौ प्रजातियों के कोपिपोड का संवर्धन एवं जैविक विवरण एकीकृत करके "समुद्री कोपिपोड़ों के संवर्धन तकनीकें" ("Culture techniques of marine copepods") नामक पुस्तक में प्रकाशित किए है.

विशाखपट्टणम तट पर एच डी पी ई पिंजरों में नारंगी चित्ती ग्रूपर का पालन किया गया। 15 महीनों की पालन अवधि के बाद मछलियों का आकार 2 कि. तक पहूंच गयी। गोल्डन ट्रेवल्ली के साथ स्नाप्पर एवं समुद्री बास के प्रग्रहण पर आधारित संवर्धन में, 160 दिनों के पालन के बाद संग्रहित मछलियां 500 से 600 ग्रा. तक बढ़ गयी. समुद्री बास के पालन पर प्रदर्शन केरल के पेरिंजनम, कारवार के परंपरागत मत्स्यन गाँव-नागनाथवाडा एवं स्माल मस्जिद, और तमिल नाडु के मंडपम, सिप्पिकुलम और कीलवैपर में आयोजित किया गया। सी एम एफ आर आइ के मंडपम क्षेत्रीय केंद्र के समुद्री मछली पिंजरे में पालित मछलियों में से एक कोबिया का इन्टरसेक्स, (रैचीसेंट्रोन कनेडम), गोनोकोरिस्टिक प्रजाति का आकलन किया गया. अपरिपक्वता के बाद, पर्याप्त वृद्धि पोम्पानो के परीक्षण में पायी गयी. द्विकपाटी समुद्री संवर्धन में, पर्यावरण अनुकूल शुक्ति पालन कार्यनीतियों को अपनाया गया और शुक्ति पालन व्यवसाय पर सी एम एफ आर आइ के परामर्शों को अपनाकर केरल सरकार ने अधिसूचना निकाली.

समुद्री जैवविविधता के क्षेत्र में, भारत के केरल, कर्नाटक, आंध्रा प्रदेश और तमिल नाडु के तटों पर जीवविज्ञानीय तौर पर संकटपूर्ण क्षेत्रों के लिए परिरक्षण योजनाएं विकसित की गयीं। भारतीय तट पर जेलीफिशों की विविधता और वर्गिकी विज्ञान की निगरानी की गयी। सी एम एफ आर आइ मंडपम क्षेत्रीय केन्द्र में दिनांक 5 फरवरी 2018 को आयोजित 72 वां स्थापना दिवस समारोह के अवसर पर जेलीसेफ प्राथमिक चिकित्सा किट का विमोचन किया गया। आंडमान द्वीपों में 5-11 अक्तूबर 2018 के दौरान प्रवाल भित्ति स्थानों का प्राथमिक सर्वेक्षण किया गया। पोर्ट ब्लेयर के हैवलोक द्वीप में दो स्थानों, एलफेन्ट बीच और हैवलोक और वन्डूर में एक स्थान में जलांदर फोटोग्राफी और वीडियोग्राफी द्वारा सर्वेक्षण तथा प्रलेखन किया गया। इस दौरान प्रवाल प्रजातियों की उच्च सांद्रता और इसके साथ प्रवाल झाड़ी मछलियों, समुद्री अर्चिनों, होलोथूरियनों, जठरपादों और भीमाकार सीपियों की विविधता भी पायी गयी। कोनिडे और स्ट्रोम्बिडे कुटुम्बों की 15 प्रजातियों से 45 जीवों का पी सी आर एम्प्लिफिकेशन और अनुक्रमण चार वंशों के लिए पूरा किया गया। तमिल नाडु में वर्धित प्रतिरूपण कवरेज के साथ CDRRP-FIMSUL II (तमिल नाडु मात्स्यिकी विभाग) समुद्री मछली अवतरण का आकलन किया गया और ऑन लाइन डेटा संग्रहण और डेटा प्रसारण की सुविधा के लिए एनमीन नामक एक मोबाइल ऐप भी विकसित किया गया। कडलुंडी-वल्लिकुन्नु सामुदायिक अभ्यारण्य से पक्षी जीवों की कुल 63 प्रजातियों की दर्ज की गयीं। इनमें से 63 आवासी प्रजातियॉ और बाकि प्रवासी थीं। भारत के कम ज्ञात समुद्री जीवों-फाइलम: निडेरिया (क्लास:ऐन्थोज़ोआ) और फाइलम: पोरिफेरा (समुद्री) पर वर्गिकीय जांच और स्पंच संपदाओं का सूचीकरण भी की गयी।

भारत के स्थूल शैवालों की संपदा गतिकी और आवास तंत्र सेवाओं के अनुसंधान के अंतर्गत, वर्ष 2018 के दौरान भारत के दक्षिण-पूर्व तट के समुद्री शैवाल कापाफाइकस अल्वरेज़ी पालन से 350 टन सूखा भार का उत्पादन आकलित किया गया, जो पिछले वर्ष से पांच गुना अधिक था। अध्ययनय किए गए तीन सूक्ष्म शैवालों में से नानोक्लोरोप्सिस प्रजाति में बेहतर फाइटोरेमिडिएशन क्षमता और वृद्धि पायी गयी और इसके बाद आइसोक्राइसिस और कीटोसिरोस प्रजातियों में भी यह क्षमता देखी गयी। तटीय समुद्री प्रदूषण पर अध्ययन जारी किया गया। पारिस्थितकीय स्वास्थ्य और टिकाऊ उत्पादन के लिए चुने गए संकटपूर्ण आवास तंत्रों के लिए बनायी गयी सूक्ष्म-स्तरीय पर्यावरण प्रबंध योजनाओं (ई एम पी) के फलस्वरूप जल निकायों में कूड़ा संचय कम करने हेतु समुदाय पर आधारित भागीदारी नयाचार विकसित किया गया। भागीदारी गॉव स्तरीय कार्यक्रम द्वारा घरेलू प्लास्टिक अपशिष्टों के संग्रहण और निकालने हेतु एक व्यावहारिक तरीका बनाया गया और इसके अनुसार यह आकलन किया

जाता है कि इस नयाचार से लगभग 345 टन प्लास्टिक का प्रभावकारी प्रबंधन किया जा सकता है। भारतीय तट पर कच्छप नीडन की गहनता का विश्लेषण करने हेतु ArcGIS 10.0 सोफ्टवेयर द्वारा स्थानिक डेटाबेस का उपयोग किया गया। बलीन तिमियों के ध्वंसन स्थानों के बारे में एक संवादात्मक मानचित्र विकसित करके संस्थान के वेबसाइट में अपलॉड किया गया। तमिल नाडु के उत्तर तटों पर विनियोजित कृत्रिम भित्तियों की परिपाक्क स्थति का निर्धारण किया गया और आवास तंत्रों, जैवविविधता, संपदा प्रचुरता, मात्स्यिकी पर कृत्रिम भित्तियों के प्रभाव और समाज-आर्थिक निहितार्थों पर भी अध्ययन किया गया।

जलवायु लचीला कृषि पर राष्ट्रीय नवोन्मेष (एन आइ सी आर ए) परियोजना के अंतर्गत समुद्र तल का तापमान बढ़ने के अनुसार तलमज्जी मछलियों के फीनोलजी एवं वितरण और रोग प्रसार पर अध्ययन किया गया। लूटजानिडे और प्रियाकांथिडे कुटुम्बों की मछलियों में यह व्यक्त हुआ कि रोग बाधा से अंडाशय के लामेलार भित्तियों का भंग हुआ, इसके फलस्वरूप एट्रोफी हुई, जिसका कारण सुपरफामिली ड्राकुनकुलोइडिया स्टालेस, 1907 में आने वाले फिलोमेट्रिड नेमटोड्स थे। मन्नार खाड़ी के वाणिज्यिक प्रमुख समुद्री शैवाल जैव भार की 8,445 टन कार्बन परिपाक क्षमता 14.5 टन CO2 उत्सर्जन/दिन के प्रति 450.3 टन CO2/दिन आकलित किया गया। भू-स्थानिक डेटासेट के साथ क्षेत्र स्तर क्षेत्रीय वेटलैंड डेटा के एकीकरण के लिए एक केंद्रीकृत वेब पोर्टल और मोबाइल एप्लिकेशन विकसित करना ताकि वास्तविक समय में वेटलैंड सलाह को सक्षम किया जा सके, इस उद्देश्य से अहम्मदाबाद में दिनांक 8 अप्रैल 2019 को भा कृ अनु प-सी एम एफ आर आइ, कोच्ची और अंतरिक्ष अनुप्रयोग केन्द्र (आइ एस आर ओ), अहम्मदाबाद के बीच एक समझौता ज्ञापन पर हस्ताक्षर किया गया। मछुआरों और ग्राहकों के बीच प्रत्यक्ष बिक्री और विपणन को सक्षम करने के लिए एक मल्टीवेंडर ई-कॉमर्स वेबसाइट और संबंधित मोबाइल ऐप विकसित किया गया, जिसका लोकार्पण दिनांक 7 दिसंबर, 2018 को एन ए एस सी, नई दिल्ली में माननीय महानिदेशक, भा कृ अनु प ने किया। अष्टमुडी और वेम्बनाड झीलों तथा अंतरज्वारीय क्षेत्रों के जल विज्ञान पर केरल में वर्ष 2018 में हुई बाढ़ के प्रभाव का निर्धारण भी किया गया।

आर्थिक निष्पादन और वितरण श्रृंखला प्रबंधन के अंतर्गत समुद्री मछली अवतरण का मूल्यांकन 52,636 करोड़ रुपए आकलित किया गया (वर्ष 2017 की अपेक्षा 0.39% की वृद्धि)। प्रमुख प्रजातियों के अवतरण के आमने-सामने भारतीय मात्स्यिकी का मूल्यांकन किया गया। राष्ट्रीय स्तर पर (स्थूल स्तर) कुल परिचालन लागत 28,950 करोड़ रुपए आकलित की गयी और शुद्ध परिचालन आय 23,686 कारोड़ थी। औसत पूंजी उत्पादकता 0.55 और समुद्री मात्स्यिकी सेक्टर में जोड़ा गया सकल मूल्य 35,266 करोड़ रुपए आकलित किया गया। समुद्री मत्स्यन तरीकों के आर्थिक निष्पादन का निर्धारण भी किया गया। समुद्री मछली की किस्मों के मूल्य व्यवहार का प्रलेखन, प्रमुख मछली प्रजातियों के अवतरण केन्द्र का औसत मूल्य तारलियों के लिए प्रति किलो ग्राम को 90.13 रु. के रेंच से और पेनिआइड चिंगट के लिए प्रति किलो ग्राम को 309.32 रुपए और नोन-पेनिआइड चिंगट के लिए प्रति किलो ग्राम को 174.15 रु. आकलित किया गया। भारत के विभिन्न राज्यों में समुद्री मछली की विपणन क्षमता के विश्लेषण से यह संकेत मिला कि भारत में विभिन्न राज्यों में समुद्री मछली विपणन दक्षता के विश्लेषण ने संकेत दिया कि केरल ने उपभोक्ता रुपये का उच्चतम 72.33 प्रतिशत और ओडिशा का सबसे कम 58.13 प्रतिशत दर्ज किया। उच्चतर बाज़ार क्षमता यह दर्शाती है कि मछुआरों को उपभोक्ता मूल्य का उच्चतम हिस्सा मिलता है और बाज़ार चैनल में मध्यवर्तियों की संख्या कम है। चुने गए तटीय राज्यों- केरल, ओडिशा, आंध्र प्रदेश, पश्चिम बंगाल और गुजरात (360 उत्तरदाताओं) के अध्ययन के परिणामों से यह संकेत प्राप्त हुआ कि सामाजिक आर्थिक चंचलता ने मछली की खपत के पैटर्न को काफी प्रभावित किया। वैश्विक मंदी और आर्थिक मंदी के बीच भारतीय समुद्री खाद्य निर्यात पर आर्थिक मंदी के प्रतिबिंब ने संकेत दिया कि निर्यात में वृद्धि हुई थी। मछली बाज़ार सूचना व्यवस्था (एफ एम आइ एस) पर लक्षित राष्ट्रीय मात्स्यिकी विकास बोर्ड (एन एफ डी बी) द्वारा वित्त पोषित भारतीय मात्स्यिकी सेक्टर में ई-विपणन हस्तक्षेप द्वारा भारत के व्यावसायिक रूप से कारोबार वाली मछलियों पर एक क्षेत्र नियमावली को 150 समुद्री और अंतर्देशीय मछली प्रजातियों के साथ अंतिम रूप दिया गया।

मात्स्यिकी गवेर्नन्स के क्षेत्र में, आजीविका और लिंग कल्याण, केरल के समुद्री मत्स्यन विनियमन (मरीन फिशिंग रेगुलेशन) (संशोधन) विधेयक, 2017 के प्रभाव को इसके अस्तित्व से पहले और बाद में बताई गई औसत संख्या का विश्लेषण करके प्रतिरूपित किया गया। यह पाया गया कि नीलामियों और मछुआरों के बीच पारंपरिक क्वासी क्रेडिट, अंतर जुड़ा हुआ मार्केट-टाईइंग सौदे, अभी भी अनौपचारिक ऋण देने का एक प्रमुख तरीका है। तीरामैत्री उद्यमों की स्थिरता को लाभ की निगरानी और मूल्यांकन मैट्रिस का उपयोग करके निर्धारित किया गया था, जिसमें विभिन्न जिलों और क्षेत्रों में संपत्ति अनुपात, मजदूरी दर का एहसास और औसत रोजगार दिन शामिल हैं। समुद्री मात्स्यिकी के क्षेत्र में लिंग मुख्य धारा के अंतर्गत, केरल, तमिलनाडु, आंध्र प्रदेश और ओडिशा से माप के उपयुक्त सूचकांकों के माध्यम से निष्पादन के स्तर और सशक्तीकरण के स्तर का आकलन किया गया।

वर्ष 2018-19 के दौरान संस्थान में 13,600 आगंतुकों को टेलिफोनिक संपर्क / ई-मेल के माध्यम से 1050 लोगों और अन्य 8,000 लोगों को प्रदर्शनियों और प्रशिक्षण कार्यक्रमों के माध्यम से प्रौद्योगिकी सलाहकार सेवाएं प्रदान की गयीं। संस्थान के प्रौद्योगिकी उत्पादों की बिक्री और आगंतुक शुल्क संग्रह के माध्यम से वर्ष 2018-19 के दौरान उत्पन्न वार्षिक राजस्व 5.78 लाख रुपए था।

Major Achievements

- Developed short-term forecasts of Indian oil sardine abundance and identified reasons explaining their inter-annual variability
- National Mariculture Policy (NMP), 2019 to ensure sustainable farmed seafood production submitted to Govt. of India and National Fisheries Development Board (NFDB)
- CMFRI refutes assignment of *Paphia malabarica* to genus Marcia due to lack of molecular evidence
- CMFRI trials production of *Varsha* series of ornamental fish feeds in commercial extruders
- CMFRI releases the sixth nutraceutical product from seaweeds to combat hypertension
- Production and supply of cobia and silver pompano fingerlings from CMFRI hatcheries cross three lakhs
- *Enmeen*, the mobile app for online fisheries data collection in Tamil Nadu and a multivendor ecommerce website and app for fresh fish sale is operational
- Initiated preparing a document on green certification of marine ornamental fish
- Successfully bred and seed production techniques standardized of two highly priced marine ornamental fishes cloudy damsel, *Dascyllus carneus* and *Pseudanthias marcia*
- Developed mussel spat stress test for providing guidance to farmers on the quality of mussel spat

Fishery Resource Monitoring

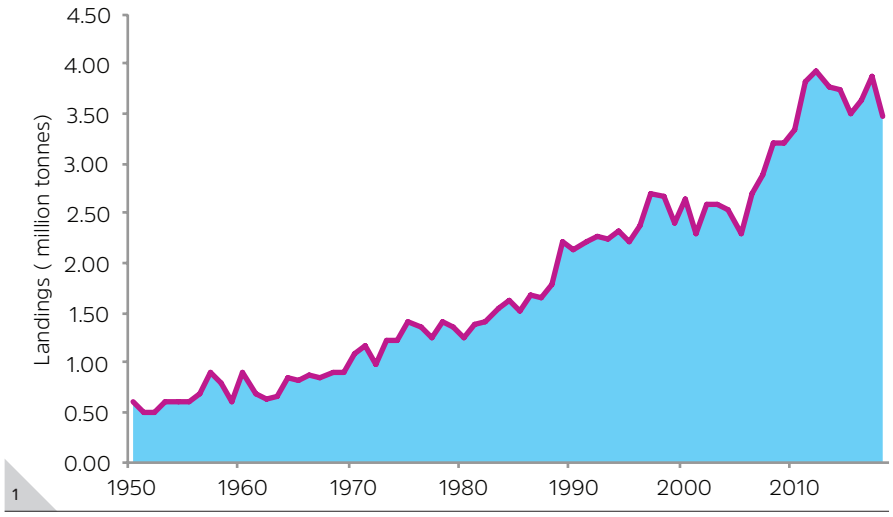
Fish harvests

Research Project: FRA/GIS/01

Fish harvests data collection system becomes online

The fish harvests data collection system of CMFRI for estimation of marine fish landings in India has been transformed into online for the first time. The web application for online data collection namely Fish Catch Survey & Analysis (FCSA), developed and installed in the database server at CMFRI headquarters,

Fishery Resource Monitoring



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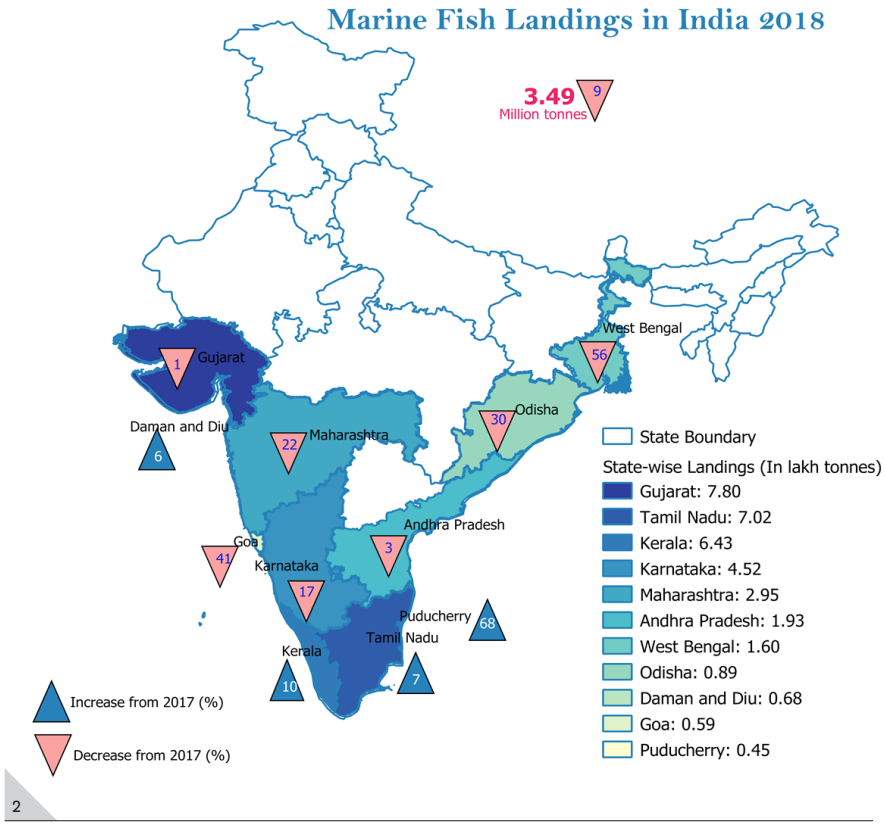


2

1. Trend of marine fish landings in India during 1950-2018
2. State-wise marine fish landings estimate for 2018

with Oracle RDBMS was used for online data entry from marine fish landing centers by the field staff through electronic tablets from January 2018 onwards and the system was used for storing and processing all the information pertaining to marine fisheries collected through the national level sample survey based on Stratified Multistage Random Sampling Design. Estimation and information retrieval was carried out using FCSA and considerable time saving was achieved.

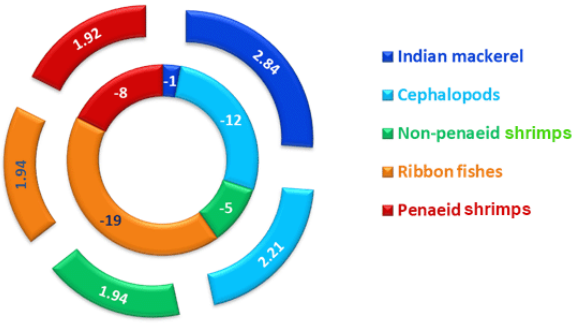
The marine fish landings data collection and estimation for the state of Kerala becomes a joint effort between CMFRI and the state fisheries department with enhanced sampling coverage under the single online data collection and estimation system of CMFRI, through a MoU between CMFRI and the Department of Fisheries, Kerala.

Marine fish landings estimated for the maritime states and Union Territories in the main land during 2018

India's marine fish production for the year 2018 was estimated as 3.49 million metric tonnes registering a decline of about 3.47 lakh tonnes (9%) compared to 3.83 million tonnes in 2017. Among the nine maritime states, Gujarat remained in the first position with 7.80 lakh tonnes landings (22.4% of total) followed by Tamil Nadu with 7.02 lakh tonnes (20.1%) and Kerala with 6.43 lakh tonnes (18.4%).

In 2018, Indian mackerel (*Rastrelliger kanagurta*) became the major resource with a contribution of 2.84 lakh tonnes (8.1%) towards the total landings, though the landings of this resource reduced by 1.4% compared to its landings in 2017. Oil sardine (*Sardinella longiceps*) dropped

Fishery Resource Monitoring



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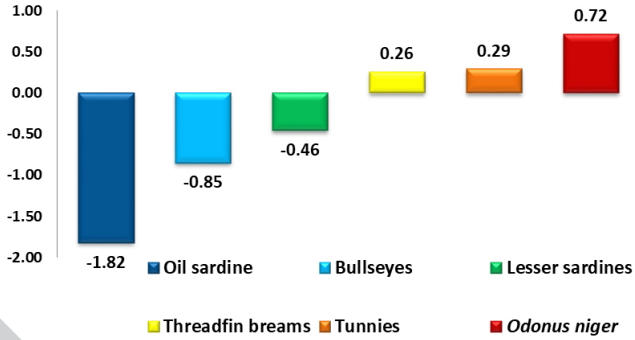

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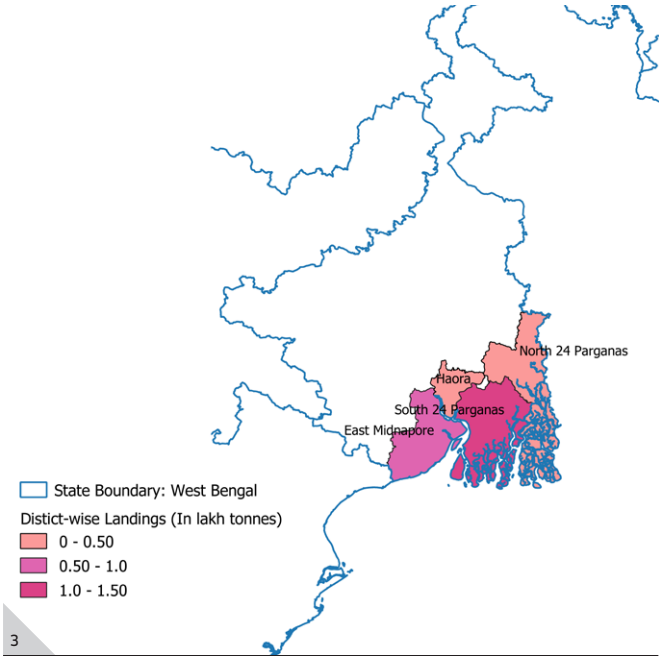

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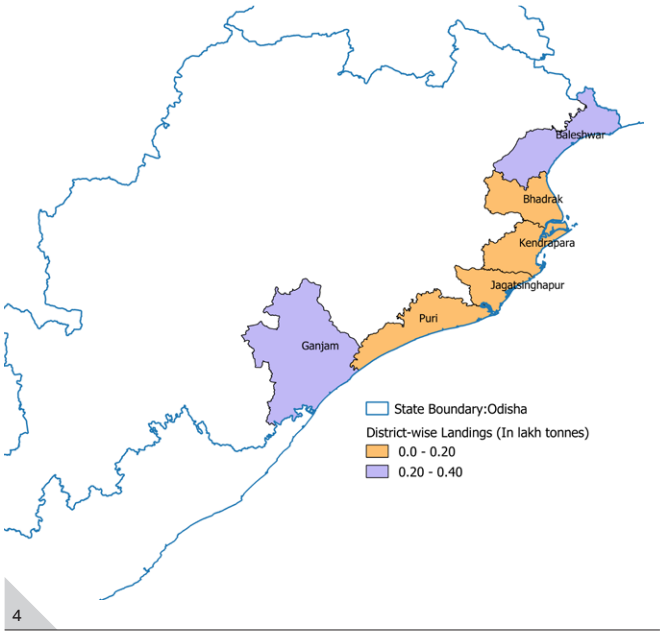
down to 9th position in 2018 from first position in 2017, with huge reduction (54%) in its landings, to 1.55 lakh tonnes from 3.37 lakh tonnes in 2017. Other major contributions were from cephalopods with 2.21 lakh tonnes (6.3% of total), non-penaeid shrimps with 1.94 lakh tonnes (5.6%), ribbon fishes with 1.94 lakh tonnes (5.6%), penaeid shrimps with 1.92 lakh tonnes (5.5%) and threadfin breams with 1.84 lakh tonnes (5.3%).

There was considerable reduction in the number of fishing days in West Bengal, Odisha, Andhra Pradesh, Tamil Nadu and Puducherry due to cyclonic storms *Titli, Gaja* and *Pethai*. Region wise contribution towards total landings in 2018 was north-east 0.25 million tonnes (7.1%), south-east 0.94 million tonnes (27.0%), south-west 1.15 million tonnes (33.1%) and north-west 1.14 million tonnes (32.8%). In all the regions, there were decrease in landings and the loss was maximum in north-east region, about 49% reduction compared to the landings in 2017.

Karnataka was in the fourth position in the marine landings with 4.52 lakh tonnes (13.0%) followed by Maharashtra with 2.95 lakh tonnes (8.5%), Andhra Pradesh with 1.93 lakh tonnes (5.5%), West Bengal with 1.60 lakh tonnes (4.6%), Odisha with 0.89 lakh tonnes (2.6%), Daman & Diu with 0.68 lakh tonnes (2.0%), Goa with 0.59 lakh tonnes (1.7%) and Puducherry with 0.45 lakh tonnes (1.3%). Compared to the landings in 2017, there was reduction in the landings in Gujarat (1%), Maharashtra (22%), Karnataka (17%), Goa (41%), Andhra Pradesh (3%), Odisha (30%) and West Bengal (56%) whereas Daman & Diu, Kerala, Tamil Nadu and

1. All India major landings (lakh tonnes) % change (inner circle) with respect to 2017
2. All India major losers and gainers (lakh tonnes) with respect to 2017
3. Map of West Bengal
4. Map of Odisha
5. Map of Andhra Pradesh
6. Map of Tamil Nadu and Puducherry
7. Map of Kerala

Fishery Resource Monitoring



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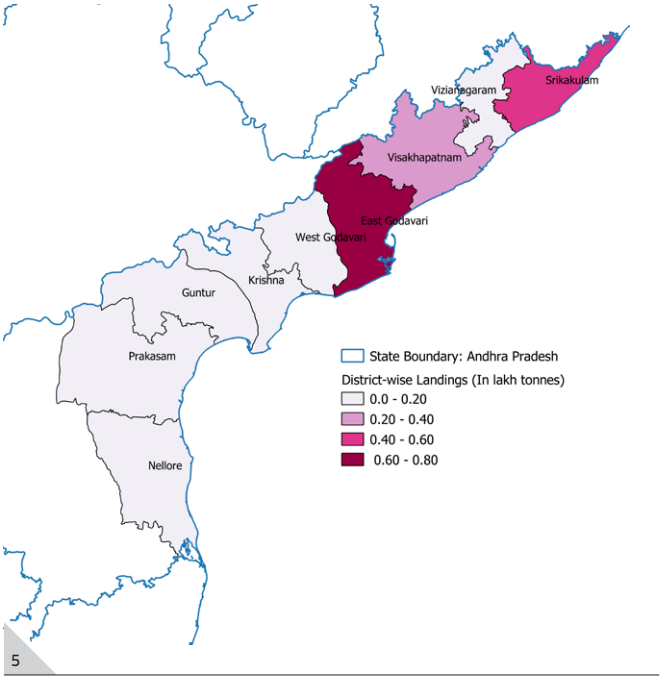

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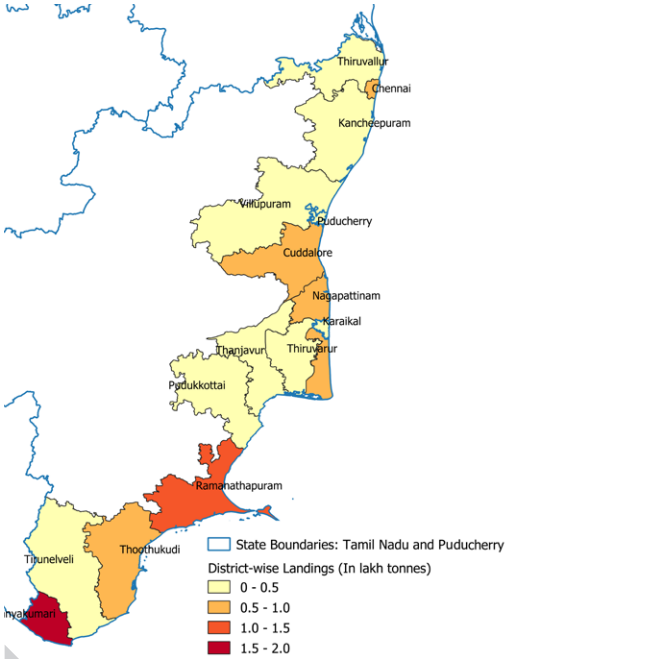

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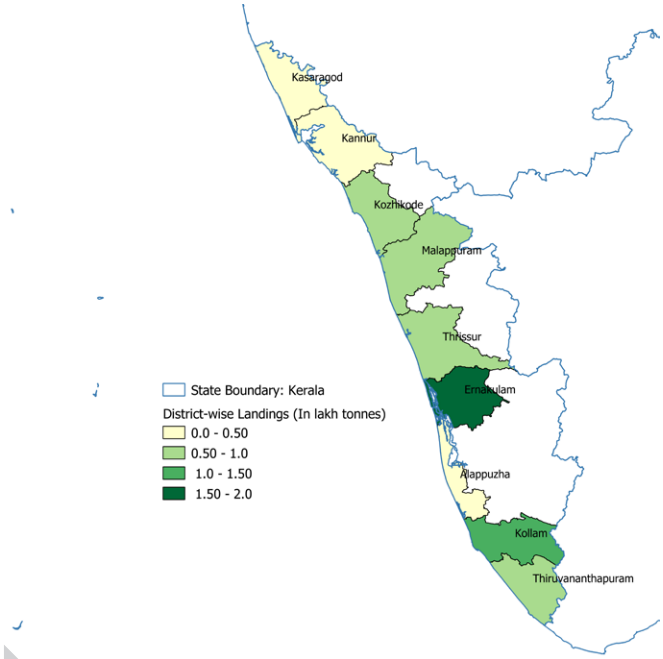

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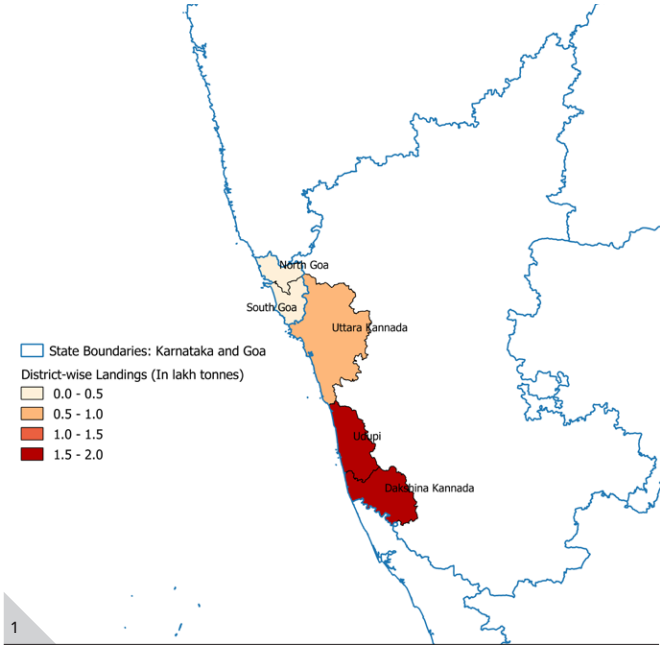
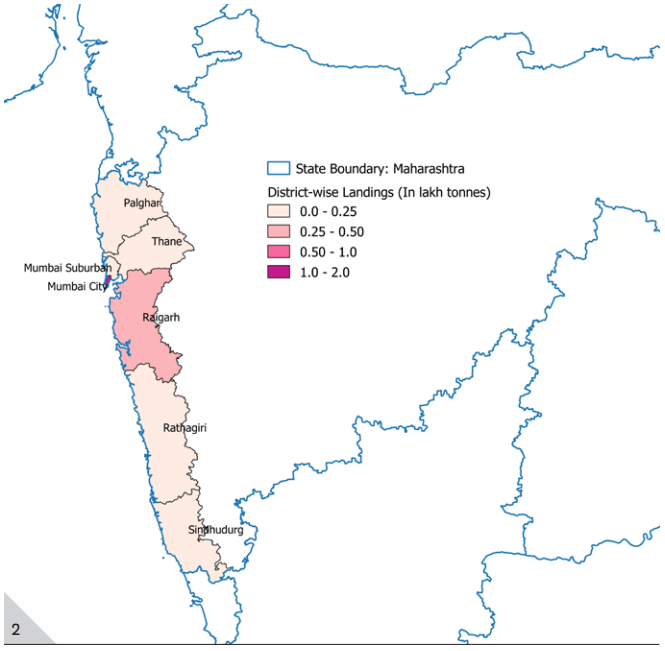
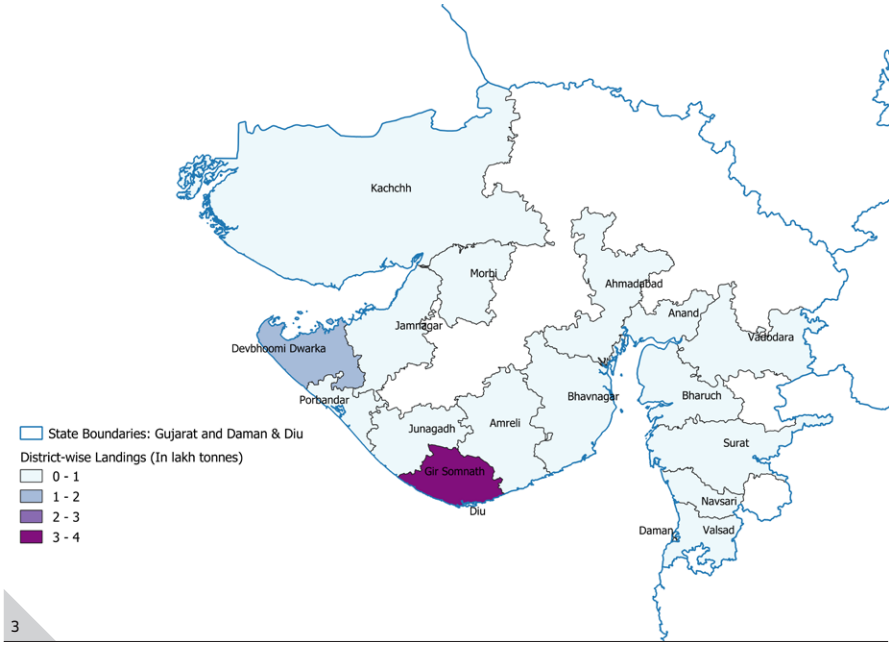
Fishery Resource Monitoring

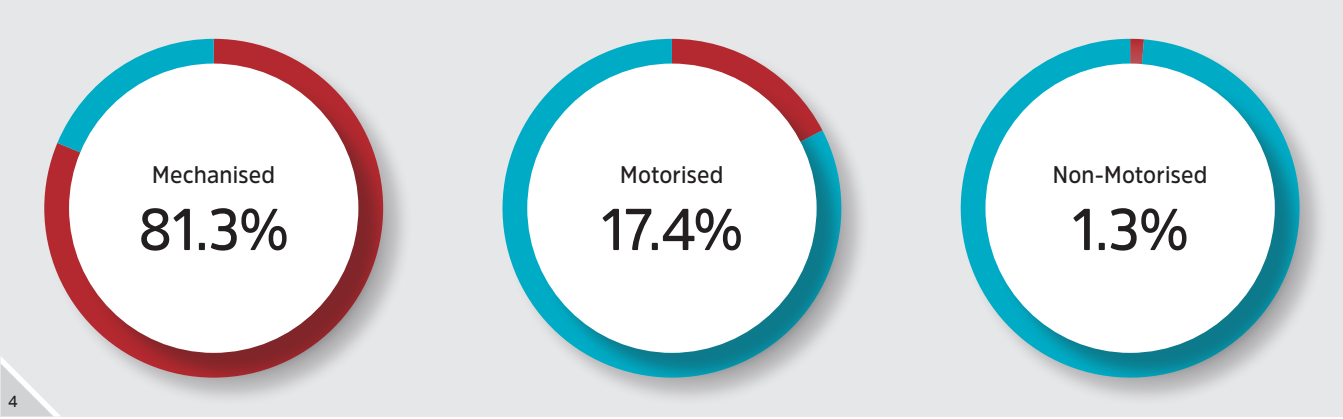






1. Map of Karnataka and Goa
2. Map of Maharashtra
3. Map of Gujarat and Daman & Diu
4. Sector wise contribution during 2018
5. Assemblage wise contributions in the marine landings in 2018
6. Comparison of number of species landed in different maritime states

Fishery Resource Monitoring



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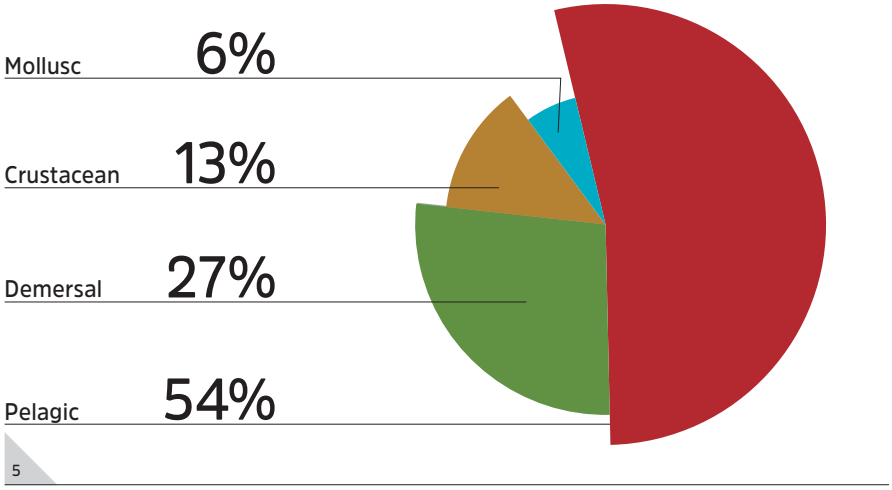

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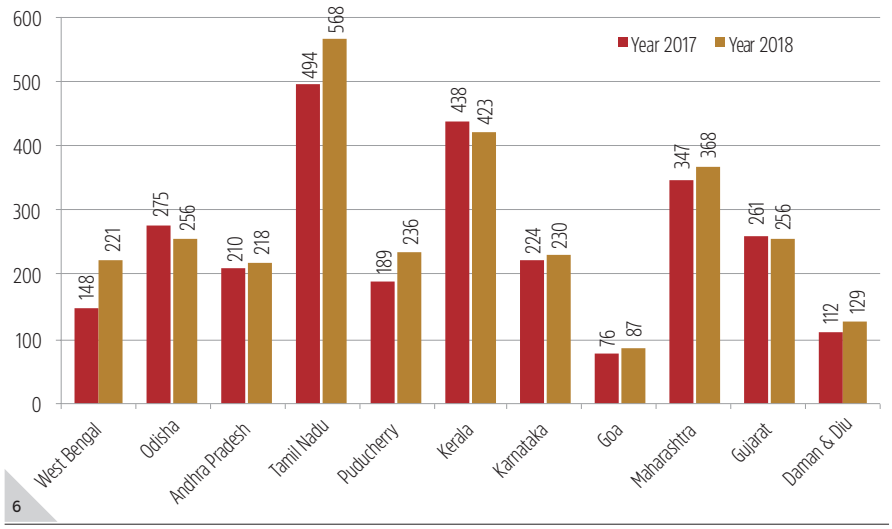

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Puducherry recorded increase in landings (6%, 10%, 7% and 68% respectively). The district wise landings in 2018 for all maritime states and Union territoies have been also analysed and depicted in map.

Maximum landings took place during the period October–December with 1.13 million tonnes (32.3%), followed by 1.00 million tonnes (28.7%) during January–March, 0.81 million tonnes (23.3%) during July–September and 0.54 million tonnes (15.7%) during April–June. Among three sectors, the major portion of the harvest was by the mechanised vessels contributing 2.84 million tonnes (81.3%) of the total landings in 2018. The contribution by motorised vessels was 0.61 million tonnes (17.4%) and the harvest by non-motorised country crafts was only 0.04 million tonnes (1.3%).

Pelagic resources dominated in the landings with 1.86 million tonnes (54%) followed by demersal resources with 0.94 million tonnes (27%), crustaceans with 0.46 million tonnes (13%) and molluscs with 0.23 million tonnes (6%).

Species Diversity

In 2018, the maximum numbers of species

Fishery Resource Monitoring

Estimated marine fish landings (tonnes) in India 2018

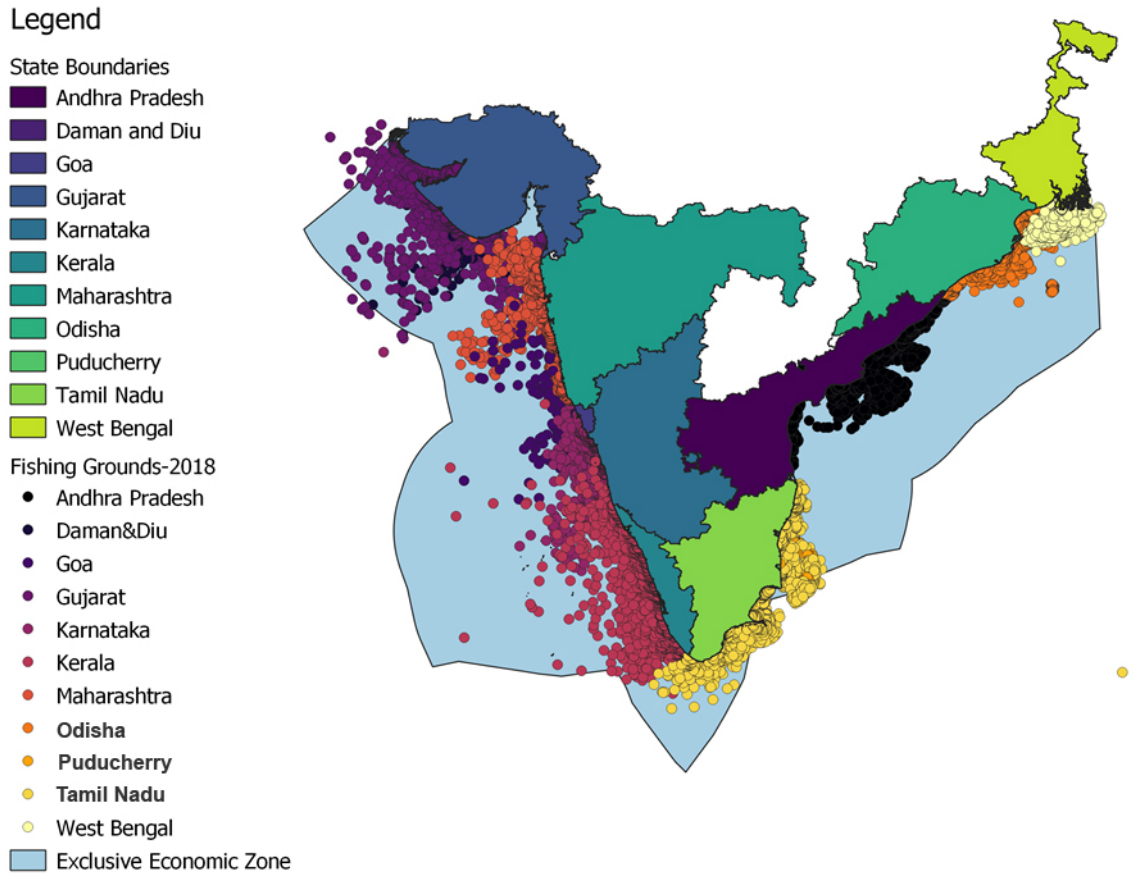
Pelagic finfish	
CLUPEOIDS	
Wolf herring	14406
Oil sardine	155450
Lesser sardines	181383
Hilsa shad	20180
Other shads	6882
Anchovies	
Coilia	40140
Setipinna	7990
Stolephorus	72792
Thryssa	52822
Other clupeids	52784
Bombay duck	112705
Half Beaks & Full Beaks	7005
Flying Fishes	2029
Ribbon Fishes	193822
CARANGIDS	
Horse mackerel	49010
Scads	130284
Leather-jackets	13947
Other carangids	126755
MACKERELS	
Indian mackerel	283896
Other mackerels	2160
SEER FISHES	
Scomberomorus commerson	29219
Scomberomorus guttatus	15585
Acanthocybium solandri	381
TUNNIES	
Euthynnus affinis	32744
Auxis spp.	16042
Katsuwonus pelamis	23147
Thunnus tonggol	7678
Thunnus albacares	27198
Other tunnies	2910
Bill Fishes	16382
Barracudas	46370
Mullets	5675
Unicorn Cod	84
Others	
Seaweeds#	15930
Odonus niger	72140
Miscellaneous	97811

Demersal finfish	
ELASMOBRANCHS	
Sharks	21154
Skates/Guitarfish	3740
Rays	17223
Eels	11797
Catfishes	54168
Lizard Fishes	69936
PERCHES	
Rock cods	51433
Snappers	11668
Pig-face breams	11985
Threadfin breams	183518
Bullseyes	58345
Other perches	50568
Goatfishes	18915
Threadfins	7992
Croakers	135451
Silverbellies	78261
Whitefish	7686
POMFRETS	
Black pomfret	15162
Silver pomfret	20966
Chinese pomfret	5051
FLAT FISHES	
Halibut	1786
Flounders	81
Soles	49142
Crustaceans	
Penaeid shrimps	192154
Non-penaeid shrimps	194011
Lobsters	2224
Crabs	57354
Stomatopods	9636
Molluscs	
Mussels, Oysters & Clams#	132531
Bivalves	2782
Gastropods	2773
Cephalopods	
Squids	119299
Cuttlefish	85655
Octopus	15890

TOTAL	**3636075**

#The estimates are based on an alternate method and are excluded from the comparisons made. The comparisons are based on 3487614 tonnes (3636075-15930-132531=3487614)

Fishery Resource Monitoring



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1. Passive geo-referencing of landings

landed along the Tamil Nadu coast (568), followed by Kerala (423) and Maharashtra (368). In 2018, a reduction in the marine species landed along Odisha, Kerala and Gujarat coast was recorded as compared to 2017. However, the other maritime states and Union territories showed the landings with higher number of species in 2018.

Spatial geo-tags for landings data: Passive geo-referencing

Passive geo-referencing was carried out to locate the spatial coordinates of presumed fishing grounds using the information on bearing and direction of fishing boat, collected all along the Indian coast during 2018 and plotted for all maritime states.

Improving the computational capacity – FISH@cmfri

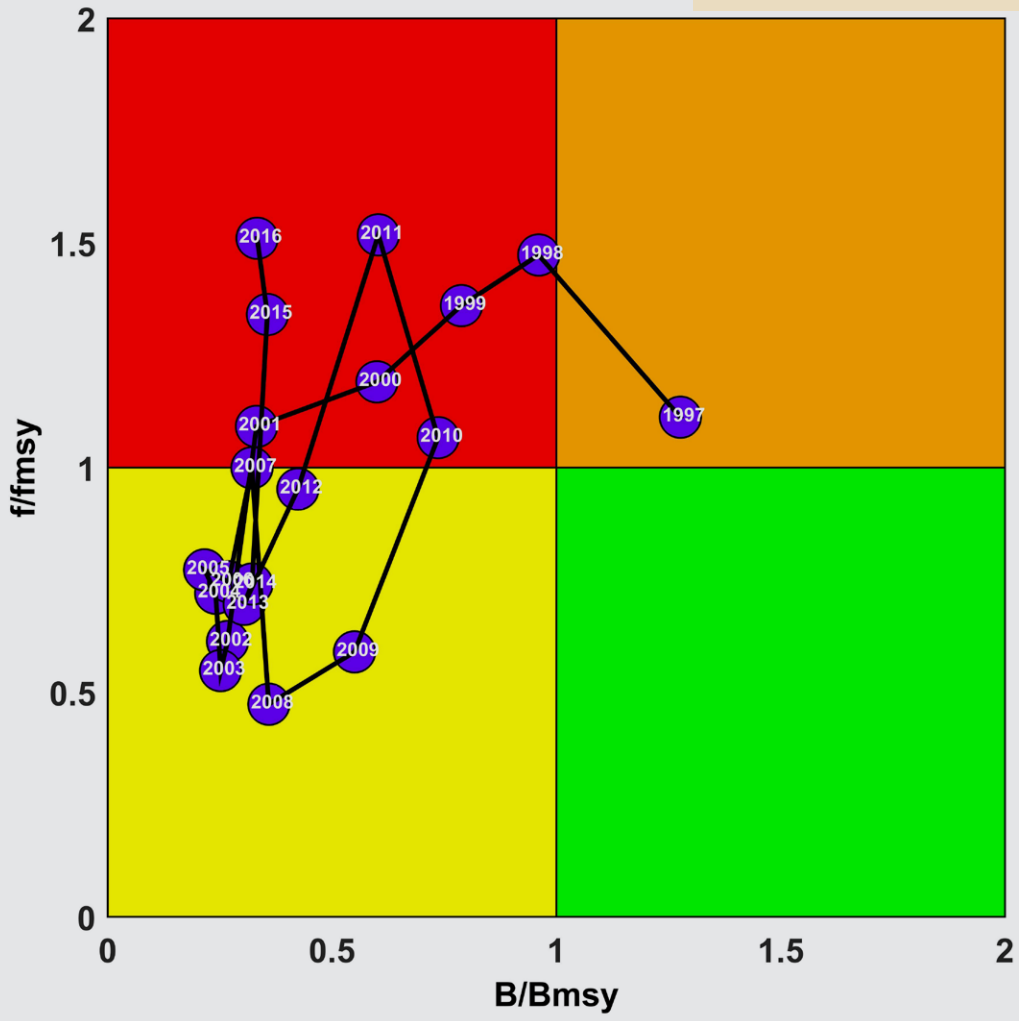
Facility for Integrated-modelling Simulation and High-end analytics (FISH@CMFRI) is a high performance computing facility in CMFRI with four Compute Nodes and three TFLOPS Computing Capacity. FISH@CMFRI having 8 Processors, 96 Cores and 64 GB Memory per node.

Fisheries and Ecosystem Modeling

Modeling biomass dynamics of marine fishery resources

Research Project: FRA/GIS/01

Estimates of maximum sustainable yields (MSY) were derived through modeling the biomass dynamics of different marine fishery resources in each maritime state in the main land of India for calculating the potential yield from the Indian EEZ. Modified versions of MICE models accommodating the multi-species and multi-gear fishery situation were used for modeling the biomass dynamics of



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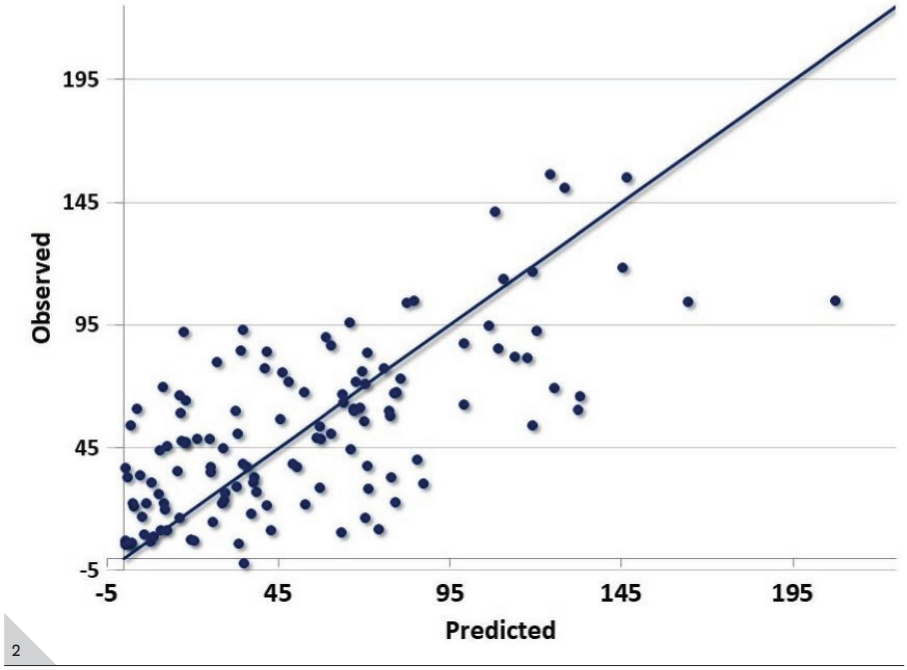
Fisheries and Ecosystem Modeling

1. Cobweb plot for the Indian mackerel fishery in Maharashtra
2. Plot of observed oil sardine landings against predicted value through kriging model for southwset coast of India



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the resources. All together 288 different models were fitted using time series data on fish catch and fishing effort in hours of fishing and estimated model parameters, MSY, fishing effort and biomass corresponding to MSY separately for each model. Using these estimates resource wise potential yield from the depth zone up to 200 m depth for each maritime state was calculated for arriving at the potential yield from the Indian EEZ. Using the potential yield estimates optimum fleet sizes for different categories of fishing fleets were also derived for each maritime state. Figure depicts the status of Indian mackerel fishery in Maharashtra through a cobweb plot of f/fmsy against B/Bmsy.

KNN and Kriging models

Research Project: FRA/GIS/01

The K-Nearest Neighbourhood (KNN) machine learning algorithm approach was attempted in modeling fishery for prediction using information on sea surface temperature, precipitation and gear wise fishing effort as design variables and fish catch as response variable. In order to find the neighbours different distance measures used are i) weighted average of absolute differences ii) principal component method iii) Euclidian distance and iv) Mahalanobi's distance. Modeling was carried out initially for oil sardine, stolephorus, ribbon fish, Indian mackerel, penaeid shrimps and cephalopods for the southwest region using quarter wise data for the period 1985-2016. The initial KNN modeling yielded 63% accuracy in the prediction for penaeid shrimps landings at the southwest coast.

Kriging modeling in which apart from regressing different functional forms of design variables on the response variable stochastic processes are included in the model to describe the dynamics of response variable with more precision, was applied to oil sardine fishery in southwest coast of India using sea surface temperature and precipitation at different lags along with gear wise fishing effort. The Kriging model could explain 67% of the variations in oil sardine fishery. Plot of observed oil sardine landings against the values derived through the kriging model is shown in the figure.

Software developed

Research Project: FRA/GIS/01

- Developed computer software in ADMB environment for ML estimation of model parameters and MSY using time series data on fish catch and fishing effort which was used for estimation of potential yield for the committee constituted for revalidation

of potential yield from the Indian EEZ.

- Developed computer software for KNN modeling and Kriging modeling.

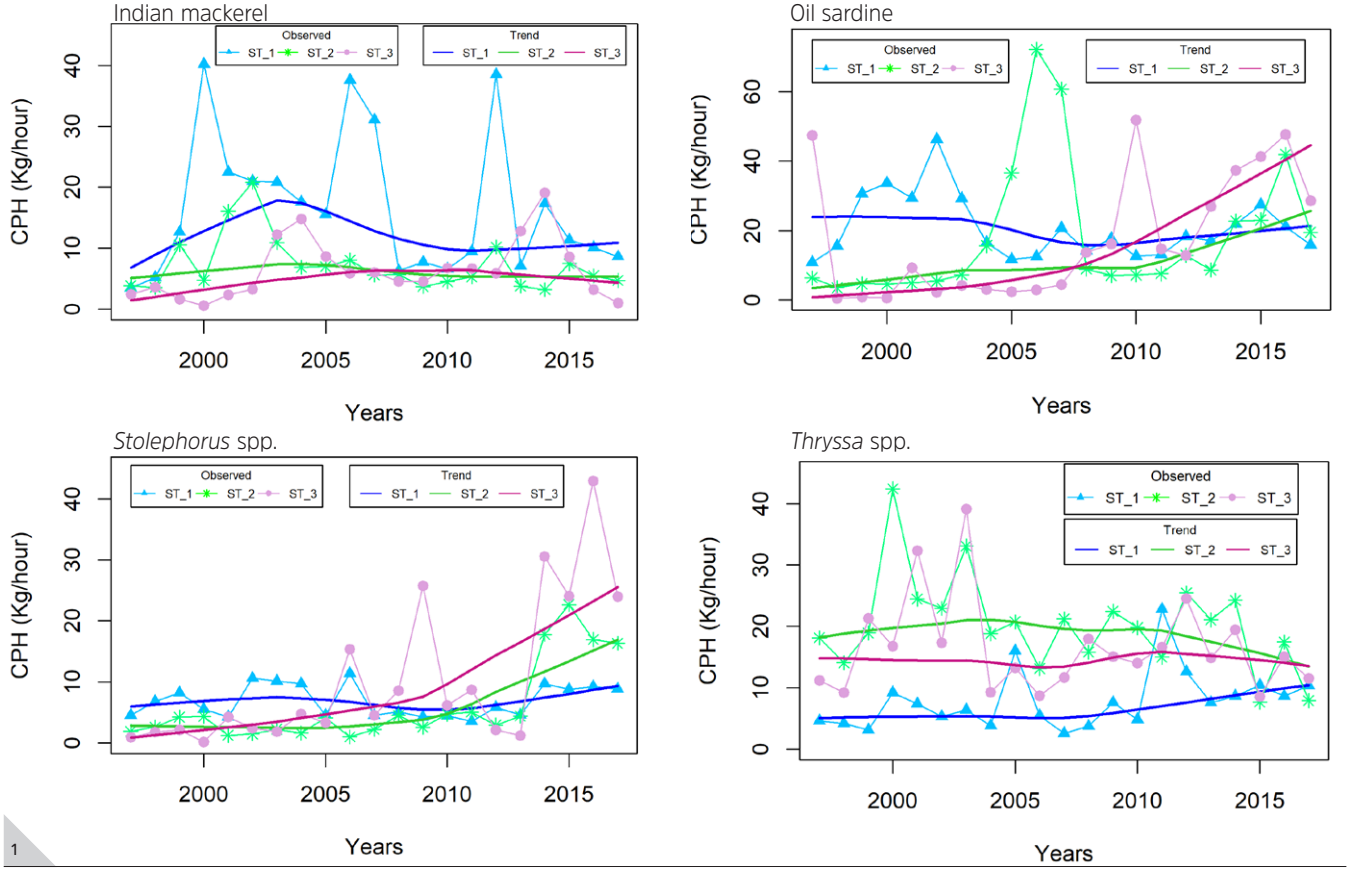
Productivity links to Upwelling and Precipitation

Research Project: FRA/CHL/02

Water quality parameters collected at 10, 20 and 30 m depth off Cochin coast in four cruises were analyzed to observe differences in pre-monsoon and post-monsoon period and found that variables such as temperature, CDOM, PAR, pH, sea pressure, salinity, conductivity, specific conductivity and sound speed were higher during pre-monsoon whereas chlorophyll-a, turbidity and density anomaly were higher for post-monsoon.

A time series analysis was performed for zonal current speed, meridional current speed, sea surface height anomaly and precipitation rate along southwest coast of India at 8 to 16° N latitude and 73 to 77° E longitude using data on current speed collected from APDRC, SODA, v3.3.1 for the period 1988-2015 at 0.50° spatial resolution, data on sea surface height anomaly (SSHA) during 1993-2015 from AVISO at 0.25° spatial resolution and precipitation rate from APDRC, TRMM, TMI, V7.1 during 1998-2014 at 0.25° spatial resolution. A significant upward change in SSHA was found at all strata simultaneously during 2007 but could not

1. Trend of resources along southwest coast of India
2. Area averaged monthly climatology time series of Chl-a, EMT, Precipitation and Silicate
3. Scatter plot of Chl-a with EMT (A) and Precipitation (B). The straight line in red colour represents the fitted line. 'r' value is shown at the top right corner



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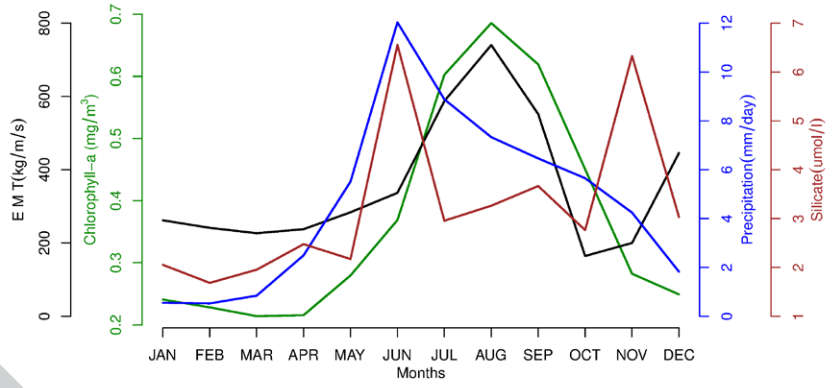
Fisheries and Ecosystem Modeling



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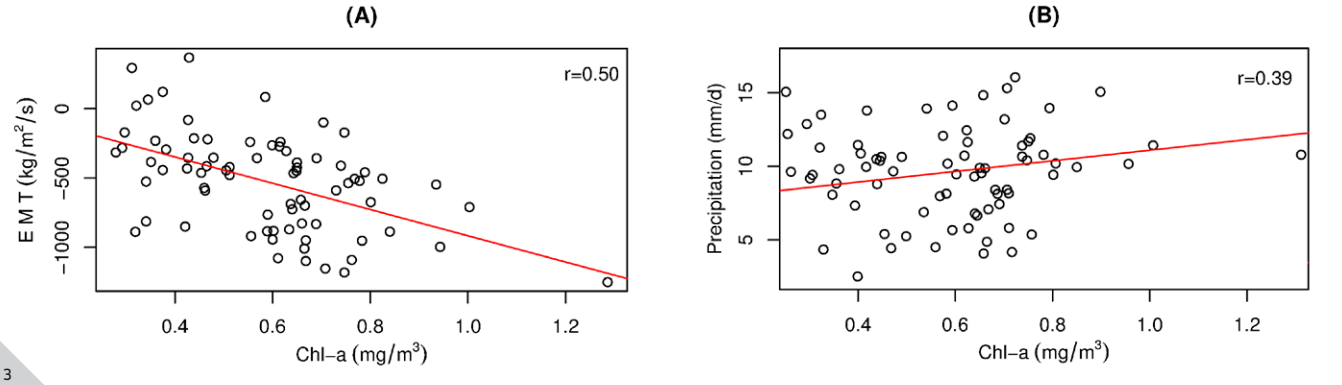

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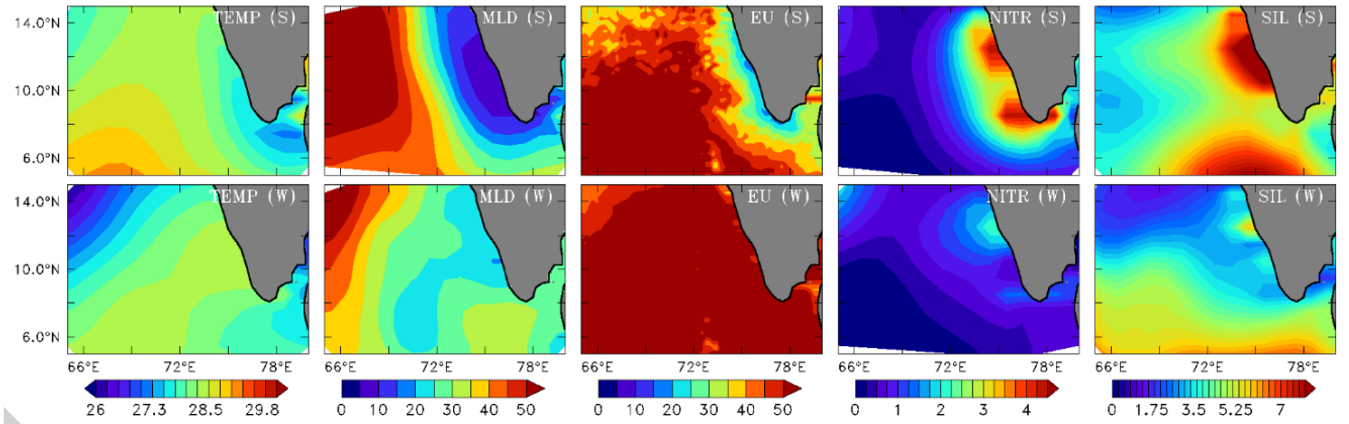
find any significant change in the time series data of meridional current speed and precipitation rate. Also trends of catch per unit hour (CPH) at each stratum were plotted for Oil sardine, Indian mackerel, *Stolephorus* spp. and *Thryssa* spp. along southwest coast of India to observe the fluctuation in the catch rate over the period.

Remote sensing data for the period 1998-2016 on chlorophyll-*a* (Chl-*a*), precipitation, silicates and sea surface winds and Ekman Mass Transport (EMT) derived from the meridional component of winds as upwelling index was used for climatology analysis which revealed that the enhancement of Chl-a along the southwest coast of India occurred during summer monsoon season and it overlaps with strong upwelling (EMT), heavy precipitation and nutrient discharge (silicate) during summer monsoon. Monthly anomalies of Chl-a, EMT and precipitation were calculated for understanding of inter-annual variability and observed a significant correlation between coastal upwelling index and precipitation with Chl-*a* in southwest coast of India. The linear step-wise regression analysis showed that the correlations of Chl-a with EMT (r=0.5) were higher than that of precipitation (r=0.39). It was found that in some specific years (during 2003-2012) when EMT anomaly is positive and precipitation anomaly is negative, the coastal productivity is



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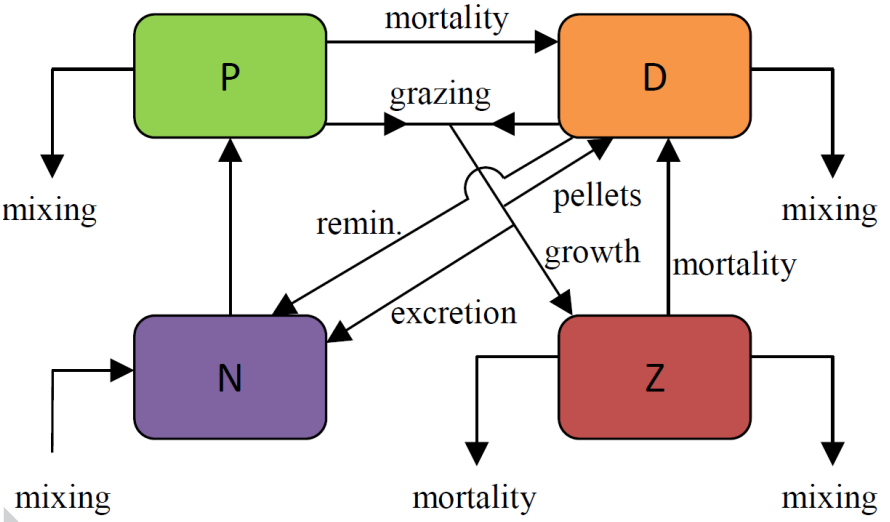

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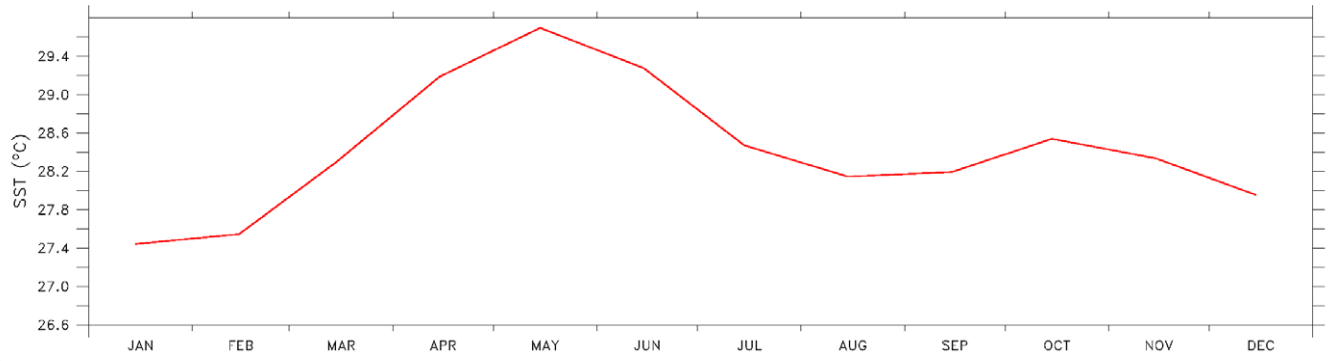
1. Climatology of SST, mixed layer depth (m), euphotic zone (m), nitrates (micro mole) and silicates (micro mole) along the south-west coast of India during the summer (upper panel) and winter (lower panel) monsoon
2. NPZD Model structure
3. Intra-annual variability of Sea Surface Temperature over the Arabian Sea (climatology)
4. Chlorophyll-a (mg/m^3) variability along the south-west coast of India during summer and winter monsoon

nominal and in these years, there was no augmentation of Chl-a even when the Ekman transport is very strong. This indicates the role of riverine nutrients from heavy precipitation on biomass production along the coastal waters of southwest coast during the summer monsoon. Thus, apart from upwelling, high precipitation during summer monsoon also contributes to coastal productivity along southwest coast significantly.

The validation of *In-situ Chl-a* values were tested with the MODIS, VISSR and OCM2 satellite products in the north-eastern Arabian Sea of the Indian coast. The mean ratio of $C_a^{OCM2}/C_a^{In\text{-}situ}$ is closer to 1 with narrow deviation (i.e., 0.97±0.27 mg m^{-3}), in contrast to the higher ratio for $C_a^{VISSR}/C_a^{In\text{-}situ}$ (1.75±0.79 mg m^{-3}) and $C_a^{MODIS}/C_a^{In\text{-}situ}$ (2.53±1.42 mg m^{-3}), which depicts the overestimation of Chl-*a* for the satellite products. The lower MPD value was noticed for the OCM2 (35.01%),

Fisheries and Ecosystem Modeling



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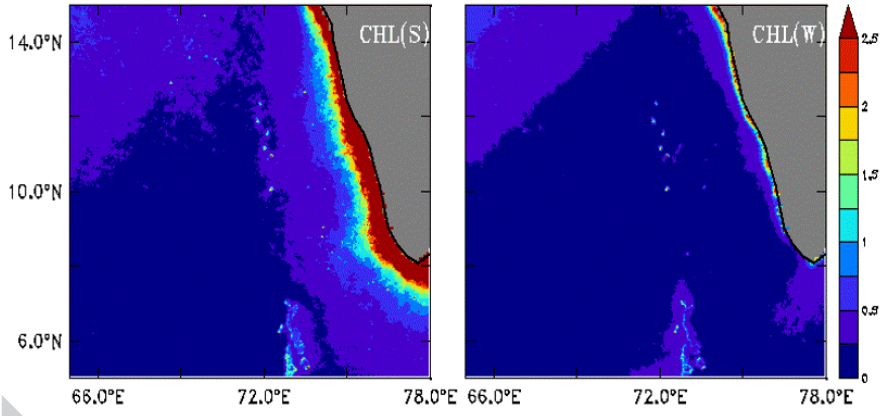

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which is having better accuracy with the *In-situ* data than the other products, i.e. VISSR (142.94%) and MODIS (192.39%). The correlation analysis between the *In-situ* and satellite Chl-a data set revealed a better correlation between *In-situ* vs MODIS (0.602, p<0.001), MODIS vs VISSR (0.589, p<0.001*), in-situ* vs OCM2 (0.562, p<0.001). The OCM2 satellite product is having less uncertainty in comparison with the other products in the region. The bias percentage is lower in case of C_a^{OCM2} product at 34.37%, followed C_a^{VISSR} (154.88%) and C_a^{MODIS} (294.02%). The RMS error was observed lower for the OCM2 (49.01%), followed VISSR (212.72%) and MODIS (427.81%). In conclusion the bias errors are significantly lower for the OCM2 than other products (MODIS and VISSR).

A Model for the Primary Production in Indian Coastal Waters

Research Project: EF/26

Annually, coastal waters of Eastern Arabian Sea (west coast of India) exhibit a bimodal variability in temperature. A slab physics NPZD model "EMPOWER" with utility of seasonal oscillation of mixed layer and temperature were used for understanding of primary productivity along the west coast of India. Results of analyses of euphotic zone depth, mixed layer depth, temperature and nutrients revealed that nitrates and silicates acts as the limiting factors for determining the productivity along the eastern Arabian Sea. Along the southwest coast of India, even though the mixed layer was limited to the vicinity of euphotic zone during both summer and winter monsoon seasons, the coast manifested enhanced productivity only during the summer monsoon. This was due to the entrainment of nitrates into the mixed layer due to the upwelling during the summer monsoon. During the winter monsoon the coast was charecterised by downwelling and nitrates were detrained from the mixed layer.

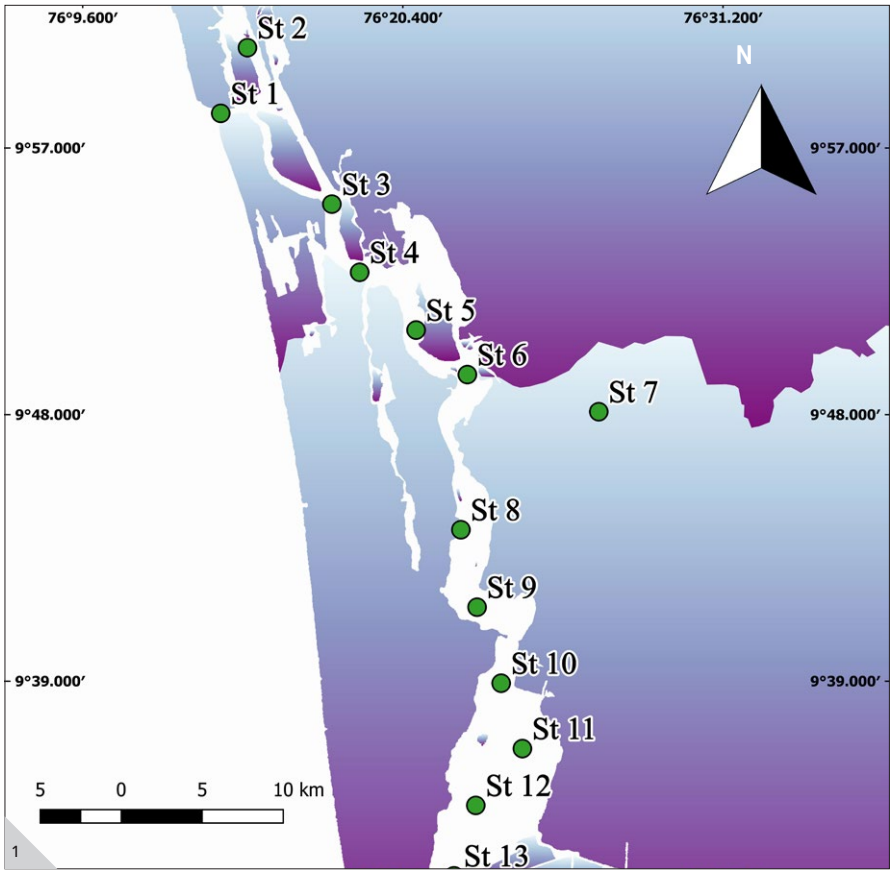
REhabilitation of Vibrio Infested waters of VembanAd Lake: pollution and solution

Research Project: DST-REVIVAL

Water eutrophication can change the amount of solar radiation penetrating the water body significantly. Thus, the optical characteristics of the natural water may be considered as indicators of the ecological state of the water body. The optical properties of natural water

bodies are influenced by some substances called optically active substances (OAS) which plays an important role to correlate the pathogenic microbes to their associations with plankton community. The study mainly focused on to understand the distribution of pathogenic microbial pollution in the Vembanad Lake, to identify causes, map distributions of carriers utilizing remote-sensing techniques, and develop forecast models that serve to anticipate hotspots of microbial infection and threats to human health.

The presence of human pathogenic bacteria such as *Salmonella*, *V. cholerae, V. parahaemolyticus* and pathogenic serotypes of *E. coli* has been reported from coastal areas. *V. cholerae and V. parahaemolyticus* are responsible for most infections by Vibrios among the aquatic microflora. During monsoon season the incidence of water borne disease outbreaks were reported from different parts of Kerala, especially on the banks of Vembanad Lake and its associated water channels which is highly populated with human settlements. In order to understand the principle reservoir of Vibrios in the lake, the *In-situ*



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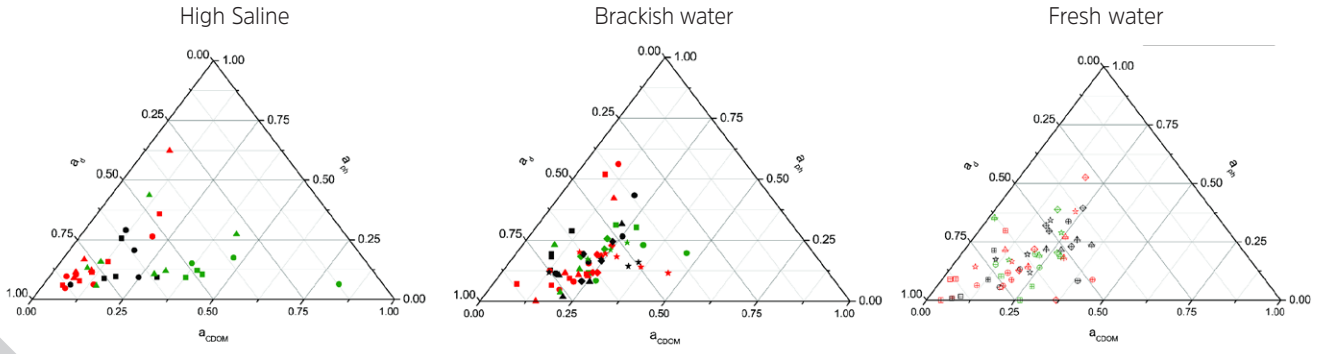

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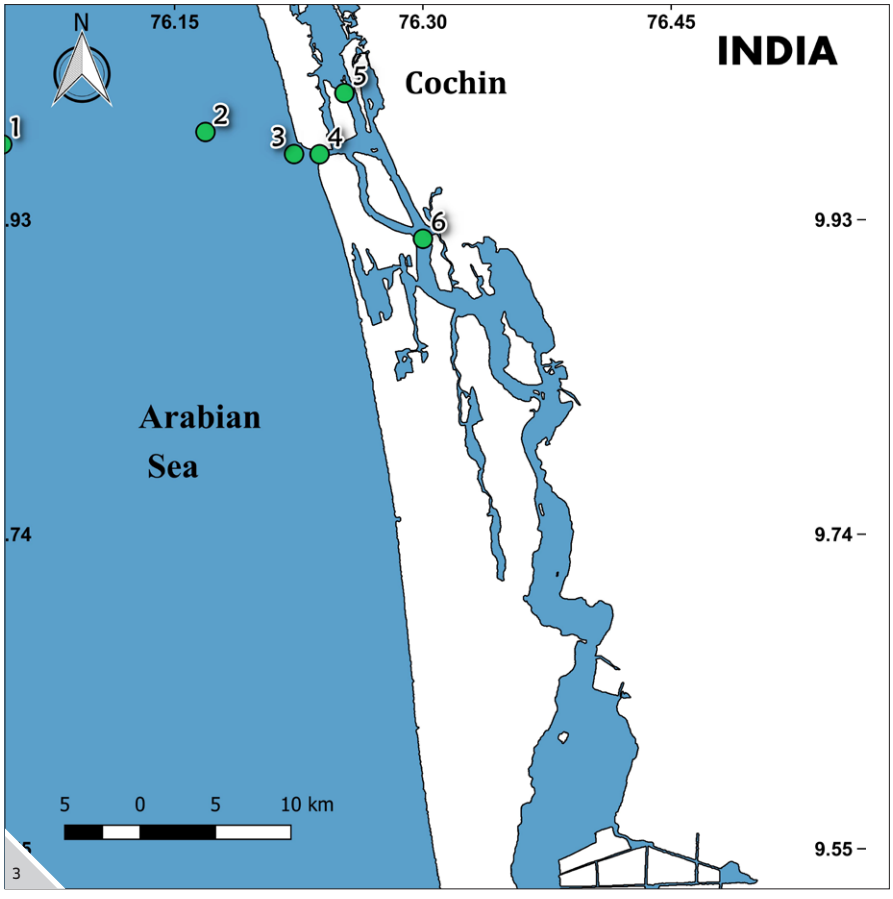
1. Study area map
2. Ternary diagram illustrating the relative contribution of phytoplankton, CDOM, and detritus absorption of three different zones of Vembanad Lake
3. Study area

data of phytoplankton, zooplankton, bio-optical parameters, physio-chemical parameters and microbiological analysis were carried out in 20 days' time interval from 13 representative stations of Vembanad Lake.

The preliminary study reveals that detritus was the major light absorbing particle in the estuary compared to phytoplankton and CDOM. During pre-monsoon season, however, CDOM was the major contributor to the absorption budget in the high saline area and co-dominated with detritus in the brackish water area. In the freshwater zone, detritus dominated in absorbing light in all the seasons. Relative absorption by phytoplankton showed an increasing trend during monsoon season whereas it was less than 50% in pre-monsoon and post-monsoon. In brackish water and freshwater area, all the three components–phytoplankton, CDOM and detritus were seen in well mixed condition. This shows that detritus plays a major role in determining the optical properties of the lake water.



Carbon dioxide Assimilation off Cochin

Research Project: ISRO

The increase in carbon dioxide leads to global warming and climate change which affect availability of fishery resources. In order to understand the air-sea carbon dioxide flux and biogeochemical cycling at seasonal to inter-annual time scales 16 samplings in Vembanad Lake (three stations) and 4 marine samplings (three off Cochin and one off Mandapam) at depths of 10, 20 and 30 m were carried out for differentiating and studying the limnological influence. CTD data was collected with sea bird CTD analyzer. Water samples for analyzing, carbon dioxide, nutrients, phytoplankton, bio-optical components (aCDOM, ap, ad, aph, a*ph) was collected from each location. Chlorophyll-a concentration was observed in the range of 1.02-32.61 µg/l with an average value of 5.37µg/l. The maximum and minimum values were observed at 30 m in September and January respectively. Higher value of aCDOM was found in station-1 (near to the coast) during September. Relative contribution of detrital absorption was moderately higher during all the sampling periods except in station two and three during the month of September.

Gujarat

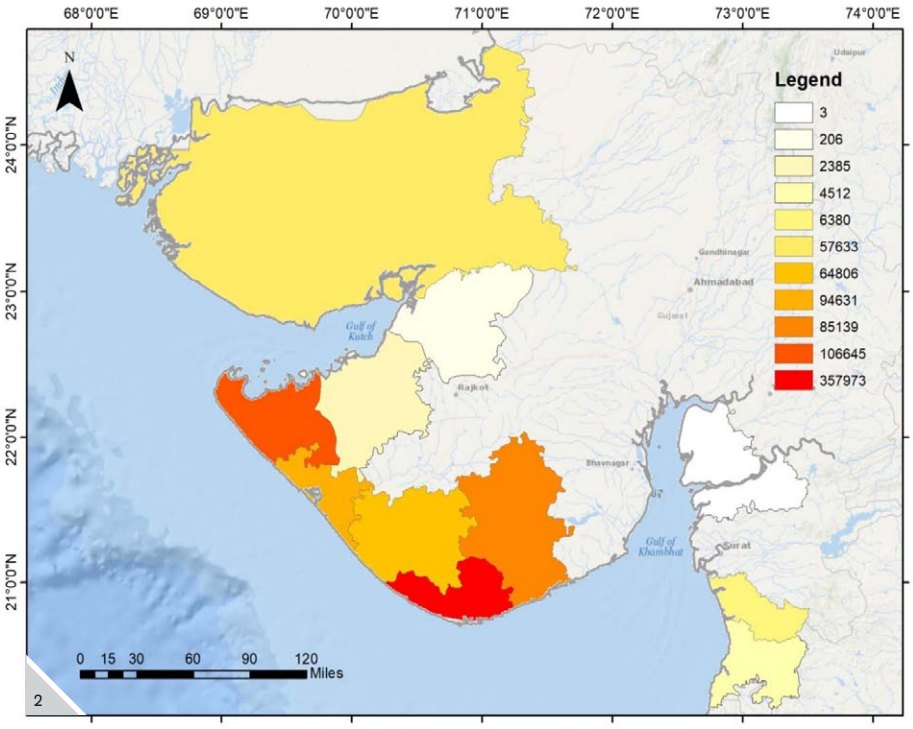
Research Project: DEM/RMS/09

The annual marine fish landings for Gujarat during 2018 were 7.80 lakh t, which is 1% lower than the previous year. The maximum catch and catch per unit effort were noticed during the post-monsoon and winter seasons, which are the peak fishing seasons in the Gujarat region. The assemblage wise marine fish landings of Gujarat for the year 2018 showed the predominance of pelagic finfish resources (38%), followed by demersal (30%), crustaceans (25%) and molluscan resources (7%). The significant increase in crustacean share is mainly due

1

Sustainable management of fishery resources: Gujarat

1. A heap of rays (Brevitrygon spp.) landed at Bhidia harbour of Veraval, Gujarat
2. Map showing district wise marine fish landings of Gujarat during 2018



to the non-penaeid shrimps, followed by penaeid shrimps and crabs. Gir-Somnath ranked first in District-wise production with 3.60 lakh t, followed by Dev Bhoomi Dwaraka (1.06 lakh t), Porbandar (0.95 lakh t), Amreli (0.85 lakh t), Junagadh (0.65 lakh t), Kutch (0.58 lakh t), Navsari (6380 t), Valsad (4512 t), Jamnagar (2385 t) and Morbi (206 t).

The fishery in the state is dominated by mechanized fishing vessels, which contributed a maximum catch of 6.96 lakh t to the total fish catch, followed by motorized fishing vessels (0.84 lakh t) and non-motorized fishing vessels (397t). The catches from the mechanized sector were mainly contributed by Multiday trawlers (MDTN), followed by Mechanized dollnetters (MDOL) and Mechanized gillnetters (MGN). The catch per unit effort (kg/h) was maximum for the MDOL (91 kg/h), followed by MTN (77 kg/h), MDTN (42 kg/h), OBDOL (36 kg/h), OBGN (13 kg/h) and MGN (7kg/h).

Pelagic resources: Pelagic fishes recorded landings of 2.83 lakh t in 2018 with 38% contribution to the total marine fish landings of Gujarat. The pelagic landings were dominated by ribbonfishes, followed by bombayduck, clupeids, carangids, Indian mackerel, tunas, and seerfishes. The estimated catch of ribbonfish with a landing of 87186.18 t, which accounted for 11.17% of total and 30.76% of pelagic fish landings. Mechanized multi-day trawlers alone contributed 76.34% towards ribbonfish landings. Bombayduck catch was 72949.26 t (recording a decrease of 5% over the previous year), formed 9.35% of the total and 25.74% of the pelagic landings during 2018. The mechanized dol net was the major gear contributing nearly 88% towards Bombayduck landings in the state. Tunas form 5.12% of pelagic fish landings of Gujarat with

Sustainable management of fishery resources : Gujarat

Biological parameters of selected pelagic resources of Gujarat

Species	Length range (mm)	Mean length (mm)	Sex ratio (M:F)	Mature %	Fecundity range	Ova diameter (µm)
R. kanagurta	180-285	246	0.59	38.8	14,064-35,420	171-740
H. nehereus	145-365	238	0.84	39.42	12,914-1,06,360	423-578
C. dussumieri	120-205	165	0.7	39	1,270-5,570	172-922
M. cordyla	147-420	325	1.13	49.50	9,060-99,594	330-800
T. lepturus	430-1095	655	1.31	55.32	45,296-2,47,504	330-800
S. guttatus	290-695	442	0.53	52	1,10,650-2,36,210	581-972
T. tonggol	425-705	554	0.57	3.63	1,50,532-5,50,960	–
E. affinis	320-710	512	1.43	21	1,35,408-1,77,118	105-800
C. hippurus	580-1420	835	1.6	69	1,25,630-2,90,302	422-985

Population and mortality parameters for the prioritized pelagic resources

Species	L_∞ (mm)	K (yr^{-1})	M (yr^{-1})	F (yr^{-1})	Z (yr^{-1})	E
R. kanagurta	303	0.82	1.54	2.16	3.7	0.58
H. nehereus	385	0.9	0.74	2.61	3.35	0.78
C. dussumeri	229	1.11	1.6	6.3	7.9	0.8
M. cordyla	497	0.8	1.25	3.15	4.4	0.72
T. lepturus	1292	0.31	0.47	1.11	1.58	0.7
S. guttatus	805	0.9	1.5	3.19	4.69	0.68
T. tonggol	914	0.3	0.58	0.72	1.3	0.55
E. affinis	808	0.6	1.02	1.2	2.22	0.54
C. hippurus	1512	0.33	0.35	0.7	1.05	0.67

a production of 14,553.48 t. *Euthynnus affinis* (37.83%), *Thunnus albaracres* (31.23%) and *T. tonggol* (21.79%) are the three main species dominated in the fishery. Carangid catch recorded as 23191.45t with *Megalaspis cordyla* as major species (32.65%). Clupeids (46660.38 t), Indian mackerel (13108.46 t) and seerfishes (10494.43 t) are the other important resources contributing to the pelagic fish landings of Gujarat.

Demersal resources: Demersal fish landings recorded was 220055 t, a decline of 3.32 % from the previous year. The maximum catch was contributed by multiday trawlers (68.8%), followed by multiday dollnetters (8.7%) and mechanized gillnetters (6.3%). Croakers formed the most dominant group with a contribution of 21.59% to the demersal landings, followed by threadfinbreams (16.87%), catfishes (11.34%), rockcods (9.65%) and bullseye (9.06%). September to March was the most productive period for the fishery with a contribution of 88.2% to the catch. The major drop in catches in comparison with previous year were recorded for *Priacanthus* (-43.7%), halibut (-38.7%), goatfishes (-26.1%), catfishes (-17.5%), lizardfishes (-16.7%) and eels (-13.9%). Elasmobranchs contribution increased with an increase of 25%, 18.9% and 52.6% recorded for

Sustainable management of fishery resources: Gujarat

1. Bulk seer fish catch landed at Bhidia fishing harbor
2. Billfishes landed at Veraval fish landing center

sharks, guitarfish, and rays respectively in 2018 when compared to 2017. Other resources which recorded an increase in landings were silverbellies, big-jawed jumpers, snappers, and threadfin breams. Unlike previous years the period January to April was most productive with a contribution of 49.3%, followed by September to December (44.5%). May to August contributed only 6.2% to the annual fishery, which includes fishing ban period.

Crustacean resources: Crustacean resources contributed 1.86 lakh t, which accounts for nearly 25% to the total fish landings of Gujarat during 2018. Minor decline of 5.68% was recorded in comparison with the previous year. Non-penaeid shrimps were the major component which contributed 75.9% to total crustacean landings, followed by penaeid shrimps (18.1%), crabs (4.2%), stomatopods (1.4%) and lobsters (0.5%). The prominent gears contributing to the crustacean landings were dol nets (75.7%) and trawlers (18.7%). The non-peaneids accounted for 3/4th of the total crustacean landings and recorded a decrease of 5.05% in landings compared to 2017. *Acetes* spp. was the most dominant group accounting for 75.3% of total crustacean landings. Non-penaeids were mainly exploited by dolnetters (91.2%), followed by trawlers (5.9%). Penaeid shrimp landing was 33742 t in 2018, which is marginally lower (-4.4%) than in 2017. Among penaeid shrimps, *Parapenaeopsis stylifera* was the dominant species with 5.30 % of the total crustacean landings. Crab landings were 7725 t in 2018, which is 14 % lower than 2017, mainly harvested by trawls (58% of the total crab landings). Other gears with significant contribution were mechanized dol nets (10.2%), mechanized gillnets (8.94%), outboard gillnets (7.5%). Lobsters catch was

Sustainable management of fishery resources : Gujarat

Growth, mortality and exploitation parameters of selected demersal species in Gujarat

Species	length range (mm)	L_∞ (mm)	K (yr^{-1})	Z (yr^{-1})	M (yr^{-1})	F (yr^{-1})	LC_{50} (mm)	E
E. diacanthus	91-520	578	0.63	2.71	1.09	1.62	14.8	0.60
N. japonicus	100-342	365	0.84	3.09	1.50	1.59	11.7	0.51
P. hamrur	115-412	457	0.65	3.01	1.19	1.82	18.2	0.60
J. glaucus	98-316	341	0.38	2.05	0.91	1.14	18.4	0.56
O. cuvieri	136-361	388	0.86	3.23	1.49	1.74	22.1	0.54
S. tumbil	148-599	624	0.61	2.20	1.04	1.16	24.6	0.53
P. argenteus	55-256	284	0.54	2.40	1.20	1.20	11.1	0.50
P. niger	101-531	590	0.58	2.68	1.03	1.65	19.8	0.62

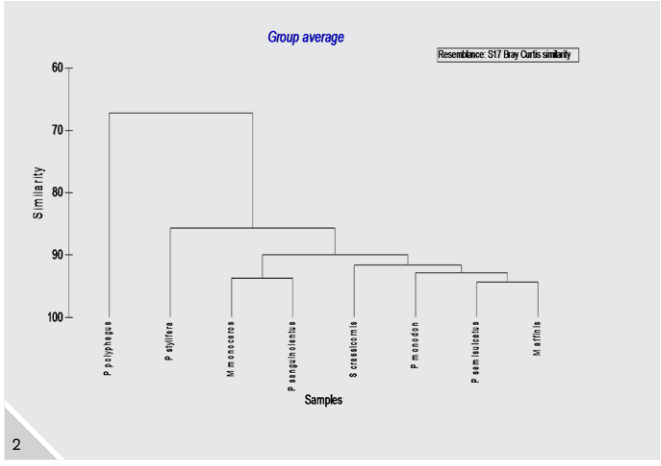
Reproductive parameters of prioritized demersal species

Species	L_{min} (mm)	Lm_{50} (mm)	Peak recruitment	Peak spawning season	Av. fecundity
E. diacanthus	19.8	271	Mar-Jun	Sep-Nov	78000
N. japonicus	14.1	212	Feb-Mar, Aug-Oct	Oct-Nov	86904
P. hamrur	16.2	216	Jul-Sep	Sep-Oct	68415
J. glaucus	13.5	202	Apr-Sep	Sep-Nov	34416
O. cuvieri	15.5	258	Jul-Sep	Oct-Dec	78545
S. tumbil	22.1	299	May-Aug	Nov-Dec	96145
P. argenteus	11.1	181	Apr-Jun, Sep-Oct	Nov-Jan	44514
P. niger	20.9	333	Jun-Sep	Oct-Dec	71356

Growth, mortality and exploitation pattern of selected crustacean species

Species	Length range (mm)	L_{inf} (mm)	K (yr^{-1})	Z (yr^{-1})	M (yr^{-1})	F (yr^{-1})	E	LC_{50}
P. monodon (F)	132-377	383.3	1.03	3.9	1.69	2.21	0.57	201.1
P. monodon (M)	133-358	364	1.11	4.15	1.82	2.33	0.56	192.2
P. semisulcatus (F)	119-249	269.6	1.38	5.75	2.26	3.49	0.61	143.1
P. semisulcatus (M)	113-239	256.4	1.45	5.94	2.38	3.56	0.6	141.3
M. affinis (F)	71-198	214.5	1.51	6.54	2.48	4.06	0.62	107.2
M. affinis (M)	71-179	193.8	1.62	6.64	2.66	3.98	0.6	110.1
M. monoceros (F)	112-259	274.1	1.4	5.41	2.3	3.11	0.57	120.8
M. monoceros (M)	103-239	256.3	1.47	5.38	2.41	2.97	0.55	122.6
S. crassicornis (F)	51-139	149.7	1.28	5.01	2.1	2.91	0.58	76.5
S. crassicornis (M)	51-134	141.3	1.35	5.12	2.21	2.91	0.57	69.3
P. stylifera (F)	64-159	171.4	1.7	6.58	2.79	3.79	0.58	86.8
P. stylifera (M)	62-153	162.1	1.9	6.65	3.12	3.53	0.53	84.1
P. sanguinolentus (F)	55-156 (CW)	168.3	1.48	5.31	2.43	2.88	0.54	82.1
P. sanguinolentus (M)	52-149 (CW)	162.2	1.5	5.01	2.46	2.55	0.51	65.4
P. polyphagus (pooled)	75-354	368.3	0.35	1.89	0.57	1.32	0.7	134.1

Sustainable management of fishery resources: Gujarat



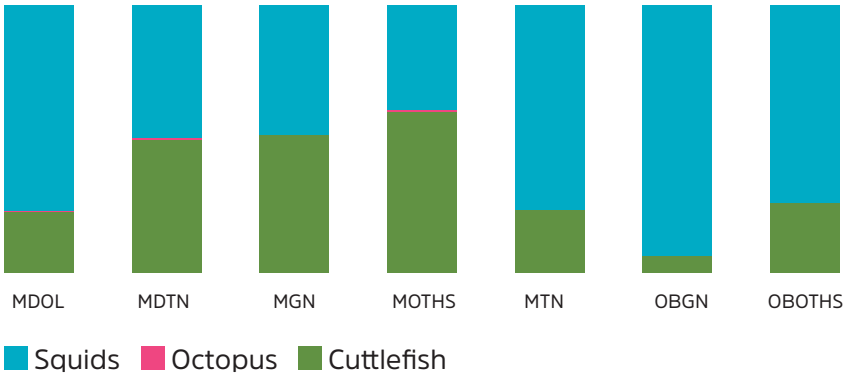
1. Mahi mahi (*Coryphaena hippurus*) landed at Veraval landing center
2. Feeding similarity (percentage) in different crustacean species

881 t in 2018, a decline of 14.6% in comparison with 2017. Lobsters are mainly exploited by outboard gillnetters (46%), followed by multiday trawlers (41%). Stomatopods landing was 2535 t in 2018, which is 22.6% lower than in 2017. The maximum landings came from mechanized dol nets (40.6%), followed by multiday trawlers (33.7%) and single day trawlers (23%). January to April contributed 53.3%, 42.2%, 36.9% and 41.8% of crabs, lobsters, non-penaeid shrimps, penaeid shrimps, and stomatopds landing respectively.

Molluscan resources: Cephalopods are the major molluscan resources landed in Gujarat with landings of 54293 t in

Sustainable management of fishery resources : Gujarat

1. A glimpse of fishery resources landed by multiday trawlers in Veraval fishing harbor
2. Gearwise landings of major cephalopods during 2018



2018. They declined by nearly 12% in comparison to 2017 and formed 7% of the total marine fish landings of the state. Major groups in the cephalopod landings were squid (50.16%), followed by cuttlefish (49.27%) and Octopus (0.58%). Multiday Trawlers (MDTN) is the major gear and accounted for nearly 91% of the total cephalopod landings. The cuttlefish fishery is dominated by *Sepia elliptica*, followed by *Sepia pharonis, Sepiella inermis, Sepia prasadi, Sepia omani, Sepia kobiensis*,etc.

Uroteuthis (Photololigo) duvauceli contributed maximum to the squid landings, followed by *U. (P.) singhalensis*. The species-wise contribution of cephalopods showed the dominance of Indian Squid, *U. (P.) duvauceli*, followed by both S. *pharonis* and *S. elliptica*, *U. (P.) singhalensis* and octopus. The diet components of the major cephalopods revealed finfish as the preferable food item followed by shrimps, crabs and molluscan groups.

Sustainable management of fishery resources: Gujarat

Biological studies of selected crustacean resources in Gujarat

Species	Peak recruitment	L_{min} (mm)	Lm_{50} (mm)	Peak spawning
P. monodon (F)	Mar-May	11.8	155.5	Dec-Jan
P. monodon (M)	Apr-Jun			
P. semisulcatus (F)	Jun-Jul	9.8	129.1	Oct-Dec
P. semisulcatus (M)	Jun-Jul			
M. affinis (F)	Mar-May	8.1	110.8	Nov-Jan
M. affinis (M)	Jul-Sep			
M. monoceros (F)	Jun-Jul	9.4	127.6	Nov-Jan
M. monoceros (M)	Jun-Jul			
S. crassicornis (F)	Jun-Aug	52	77.7	Nov-Jan
S. crassicornis (M)	Apr-Jul			
P. stylifera (F)	Jun-Sep	53	89.6	Sep-Dec
P. stylifera (M)	Jun-Sep			
P. sanguinolentus (F)	Jun-Jul	58	87.2	Nov-Feb
P. sanguinolentus (M)	Mar-Jun			
P. polyphagus (pooled)	Jul-Sep	143	170.3	Nov-Jan

Biological studies of selected commercially important cephalopods

Species	Length range (mm)	Mean Length (mm)	Sex Ratio (M:F)	Mature (%)	Lc_{50} (mm)	Lm_{50} (mm)
U. (P) duvauceli	42-247	111.5	**1**:0.80	78.53	110.4	114.1
U.(P) singhalensis	65-274	154.4	**1**:0.67	88.12	119.8	120.4
O. membranaceus	38-262	81.2	**1**:0.65	56.75	-	-
S. elliptica	48-222	114.1	**1**:0.74	61.20	106.2	105.1
S. inermis	35-147	65.3	**1**:0.95	44.25	64.8	61.5
S. omani	31-108	75.4	**1**:0.57	33.14	-	-
S. pharonis	121-364	225.1	**1**:0.91	31.26	181.2	165.0

Maharashtra

Research Project: CFD/RMS/13

The estimated marine fish landings in Maharashtra during 2018 was 2.95 lakh t with 22.5% decrease from previous year (3.81 lakh t in 2017). The major fishing gears that supported the fishery were trawl net (54.7%), Set bag net (SBN, dol net) (22.7%), purse seine (15.2%), and gill net (7.1%) while prominent species/groups that contributed to the fishery of the state were Non-penaeid shrimps (12.6%), penaeid shrimps (11.4%), croakers (10.2%), threadfinbreams (8.4%), Indian mackerel (7.1%), Bombayduck (5.6%) and squids (5.2%).

1

Sustainable management of fishery resources: Maharashtra

Pelagic resources: contributed 38% to the total marine catch in Maharashtra with an estimated 1,11,244 t which is 26% lower than 2017. Major gears contributing to the fishery were purse seines (34%), trawlers (33%), SBN (19%), gillnets (14%). Indian Mackerel contributed 19% to the pelagic fish landing followed by Bombayduck (15%), ribbonfish (13%), horse mackerel (10%), Golden anchovy (8%), seerfish (7%) and tuna (5%).

Demersal resources: contributed 0.84 lakh t (28.7%) to the total fish landings. Major demersal finfishes, croakers contributed 35.4% followed by threadfinbreams (29.1%), catfishes (8.1%) and silver pomfret (4.7%). Trawlers contributed 82.1% to the demersal fish landings, followed by purseseines (5.9%) and SBN and gillnet (5.8%).

Crustacean resources: formed 24.8% (73,298 t) of total estimated marine fish landings of Maharashtra. Major contributors were non-penaeid shrimps 37,120.9 t (50.6%), penaeid shrimps 33,753.8 t (46%), crabs 1499.5 t (2%), stomatopods 696.7 t (1%) and lobsters 227.3 t (0.3%). Crustaceans were mainly landed by SBN (*dol* netters) (54.7%) and trawlers (44.6%).

Cephalopod resources: were estimated at 20812 t, squids dominated with 74% followed by cuttlefish (24%) and octopus (2%). The major fishing gear that supported the fishery were trawl net (98%) with 3.81 CPH.

Golden anchovy: contributed 3% (9,207 t) to the total marine fish landings. SBN landings contributed 41%, trawlers (56%) and gillnet (2%). The size range of *C. dussumieri* was 110-188 mm. Gravid fishes were observed in November to March, and August. Stomach contents consisted of copepods, cladocerans, Acetes spp., amphipods, shrimps, ostracods and other crustaceans.

Indian mackerel: with 21,070 t (7%) formed the op most species amongst the pelagics. Major share of landing (59%) was contributed by purse seiners followed by gillnets (24%) and trawl (16%). The size range in fishery was 145-296 mm. Females were in mature and gravid condition during February to March, October and December. Gut analysis showed dominance of *Coscinodiscus* spp, copepods, foraminifera, shrimps, *Loligo* spp., other crustaceans, *Acetes* spp etc.

Bombayduck: formed 6% (16,576 t) of the total fish catch. Of this 64% was by SBN and 36% by trawlers. Their size ranged from 121-387 mm. Mature and gravid females were noticed during January, August and December. Diet contents consisted of *N. tenuipes, Acetes* spp, *Coilia dussumieri*, juveniles of Bombayduck and *Bregmaceros* sp, *gobids, O. cuvieri, Solencera* spp., *ribbonfish, shrimps and Polynemus* sp.

Ribbonfish: contributed about 5% (15,006 t) to the total fish catch. Trawlnet contributed (79%) followed by SBN (13%), purseseine (6%) and gillnet (2%). *Trichiurus lepturus* was the major species with size range of 235-1150 mm. Mature and gravid females observed during January to March, October to December. Major food items observed were *Acetes* spp., *T. lepturus, Loligo duvauceli, sciaenids, shrimps, ribionfish, mackerel, myctophids, Bregmaceros, threadfinbream etc.*

Seer fishes: Seerfishes contributed 69,64 t (2.3%) to the total catch of which *S. commersoni* (56%) and *S. guttatus* (44%) were the only two species contributing to the fishery. About 50% of *S. guttatus* was by gillnets followed by purseseine (20%), trawl net (1%) and SBN (15%). Size of *S. guttatus* ranged between 134-965 mm. Females in mature and gravid stages were noticed in March.

1. Drying of Bombay duck on poles at Vasai, Maharashtra
2. Tune landing at Sassoon dock, Maharashtra

Sustainable management of fishery resources: Maharashtra

1

Gut content analysis showed *Acetes* spp., *sardine, stolephorus* and *Bregmaceros* sp. as its major food.

Tuna: Estimated landing of tuna was 5869 t. About 82% of the fishery was by purseseine followed by gillnet (9%) and trawlnet (8%). *E. affinis* ranged was 310-790 mm, *Auxis thazard* 235-582 mm and 280-690 mm for *T. tonggol.* Mature fishes were observed during March for all three species. Among the tunas, 63% were contributed by *E. affinis* followed by *T. tonggol* (19%) and *Auxis* spp. (13%).

Croakers: contributed 10.2% (30,047 t) to the total catch. Trawl was the major gear that caught croakers (93.3%) followed by SBN (dolnet) (3.2%) and gillnet (3.1%). Trawl CPUE was 17.6 kg h^{-1}. Juveniles dominated the fishery, major species in trawl fishery were *Johnioeps* spp. (46.8%), *Johnius* spp. (34.5%), *J. belangerii* (5.27%), *Otolithoides biauritus* (5.2%) and *Otolithes* spp. (5.5%).

Threadfinbreams: accounted for 8.4% of the landings and were exclusively exploited by trawlers 98.7% (24378.8 t) and SBN (1.3%). In trawls dominant species was *Nemipterus japonicus* (54%), *N. randalli* (38.1%) and *N. bipunctatus* (7.9%). Fishery was dominated by juveniles, with a mean size of 104 mm and 177 mm for *N. randalli* and *N. japonicus* respectively. Average trawl CPUE was 4.6 kg h^{-1} with high CPUE in April (10.3 kg h^{-1}) and May (11 kg h^{-1}).

Catfishes: accounted for 2.3%, with 6842 t. Purseseine was the major gear in harvesting catfishes with 61.4% total catch, followed by trawl (23.9%) and gillnet (11.5%). In trawl, fishery was supported by *O. militaris* (40.7%), *P. tenuispinis* (19.3%), *P. dussumieri* (18.5%), *Nemapteryx caelata* (13.3%), *N.thalassina* (2.7%). Size range of *O. militaris* was 184.5-464.5 mm (mean size 315 mm), juveniles were common from December to February.

Pomfrets: Silver pomfret (*Pampus candidus*) estimated catch was 3946 t. Fishery was dominated by juveniles and high juvenile exploitation was observed from February to May. SBN accounted for 59.4% of catch followed by gillnet

Sustainable management of fishery resources: Maharashtra

1. Mackerel landed at Malvan fish landing center
2. Map showing district wise marine fish landings of Gujarat during 2018

(29%). Size range in the SBN fishery was 74.5-284.5 mm (mean size 143 mm). Annual catch per SBN unit was 11.2/SBN vessel. Black pomfret (*Parastromateus niger*) formed 773.3 t.

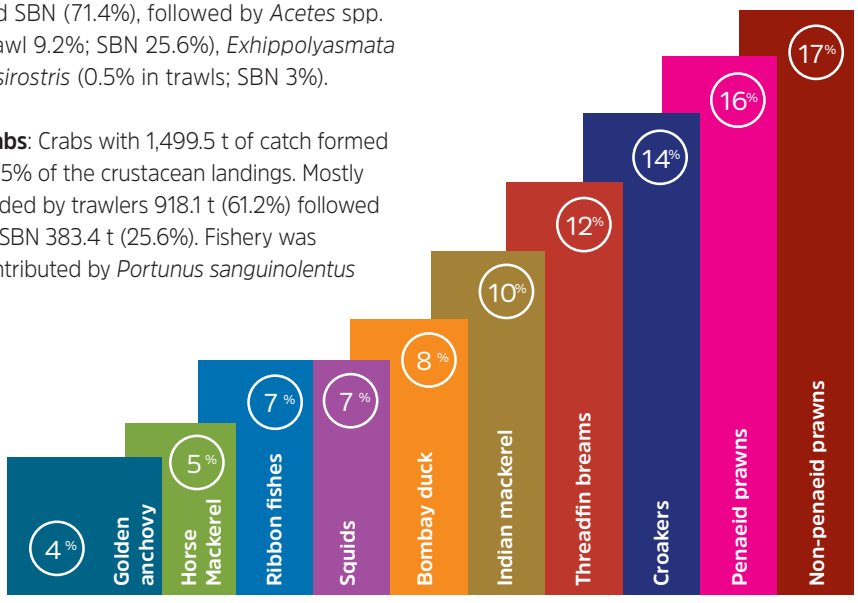
Penaeid shrimps: landings during 2018 were 33,753.8 t. Major landings of penaeid shrims were by trawlnet 28586.9 t (84.7%) with a catch rate of 5.36 kg/hr followed by SBN 4978.1 t (14.8%). *Parapenaeopsis stylifera* was the major penaeid shrimp landed (50%) followed by *Metapenaeus affinis* (21.6%), *M. monoceros* (17%), *Solenocera crassicornis* (6%) and *S. choprai* (1.8%). *P. stylifera* was the major contributor (62%) to penaeid shrimp landing by SBN followed by *P. sculptilis* (16.5%), *M. brevicornis* (11.6%), *M. affinis* (6.5%) and *S. crassicornis* (2.9%).

Non-penaeid shrimp: landings during 2018 were 37120.9 t. They were contributed by SBN 34471.4 t (93%) followed by trawlnet 2594.4 t (7%). *Nematopalaemon tenuipes* was the major non-penaeid shrimp in trawl (90.4%) and SBN (71.4%), followed by *Acetes* spp. (trawl 9.2%; SBN 25.6%), *Exhippolyasmata ensirostris* (0.5% in trawls; SBN 3%).

Crabs: Crabs with 1,499.5 t of catch formed 2.05% of the crustacean landings. Mostly landed by trawlers 918.1 t (61.2%) followed by SBN 383.4 t (25.6%). Fishery was contributed by *Portunus sanguinolentus* (39.8%) followed by *Charybdis feriata* (34%) and *Portunus pelagicus* (17.8%).

Squids: Four species i.e. *Uroteuthis (Photololigo) duvaucelii* (71.6%), *U. (P) edulis* (1.2%), *U. (P) singhalensis* (0.2%) and *Loliolus hardwiki* (0.8%) formed the commercial landings. The group showed 44.78% decrease compared to the previous year. Trawl was major gear with CPUE 2.81 kg h^{-1} for squid with peak landing during post-monsoon month. Size range of *U. (P) duvaucelii* in fishery was 44.5–324.5 mm (mean size 147.18 mm), juveniles were common in December.

Cuttlefish: *Sepia pharaonis* (14.7%), *S. elliptica* (1.1%), *S. aculeata* (4%) and *Sepiella inermis* (4.6%) formed the cuttlefish fishery. Cuttlefish fishery also showed sharp decrease (50.65%) compared to the previous year. The size range *S. pharaonis, S. elliptica and S. inermis* in trawlers was 98 – 348 mm, 55 – 160 mm and 25 – 100 mm respectively.



Top 10 groups and % share to Maharashtra landing

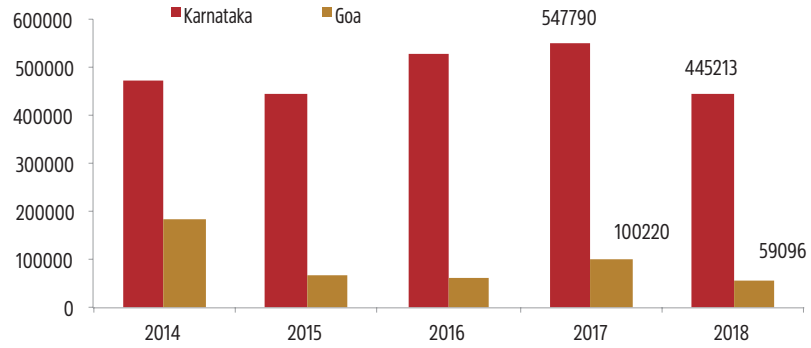
2

Karnataka and Goa

The total estimated marine fish landings in Karnataka (4,45,213t) and Goa (59,096t) registered 18.7% and 41.0% decrease during 2018 respectively as compared to the previous year. The landings during the year were 8.7% and 37.8% less in Karnataka and Goa respectively as compared to the five year (2014-2018) average landings. The landing centre and retail centre value of the marine fish landings in Karnataka were 6,442 crores and 10,470 crores respectively. Similarly in Goa, the landing centre and retail centre values were 920 and 1312 crores

1

Sustainable management of fishery resources: Karnataka and Goa



2

1. Boats berthed at Mangalore fishing harbour
2. Trends in annual total marine fish landings in Karnataka and Goa
3. Contribution (%) of different sectors and gears to the total landings in Karnataka
4. Contribution (%) of different gears to the total landings in Karnataka

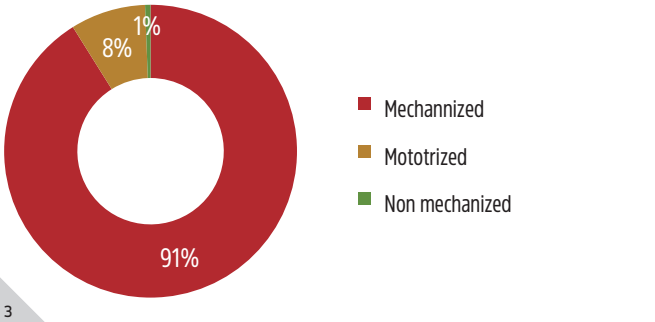
respectively. The share of Karnataka and Goa to the all India retail value during the year was 13.03 and 1.36 % respectively. The main reasons for the decline in total landing during the year is mainly due to Steep decline in the catch of oil sardine (60%) and mackerel (24%), reduction in actual fishing days due to frequent cyclonic weather conditions, self-declared fishing holidays due to conflicts between different fishing sectors as a result of strict implementation of fishing regulation orders sand voluntary abstinence from fishing to avoid exploitation of the low valued red-toothed trigger fish that was abundant in the fishing grounds since November. Unusually high landing of white sardine, croakers and carangids in shore seines and near-shore waters was observed during September-October. Locals attributed this bounty catch to the strict implementation of the regulatory measures on the ban on pair trawling in Karnataka this year.

The mechanized sector comprising mainly the trawlers (64 and 11%) and the purse seiners (26 and 87%) was the major contributor to the catch in Karnataka and Goa respectively.

Considering the importance of trawlers in the marine fisheries sector of the country, a national project to develop guidelines for best practices for trawl fishery in India was initiated and geo-coded data collection on trawling operations, catch/by-catch from selected landing centres of the country has been completed. Further, perceptions of stakeholders engaged in trawl fishery were collected through direct interactions or through questionnaires. The historical developments and time scales on the evolution of trawl fishery in all the maritime states were prepared.

The pelagic resources continued to be the dominant group in both states followed by the demersal fishes, crustaceans and Molluscs.

In all 57 species landed were studied in detail for their fishery and biology. The stock status of species/groups landed in Karnataka was estimated using the Rapid Stock Status Assessment (Mohamed *et*



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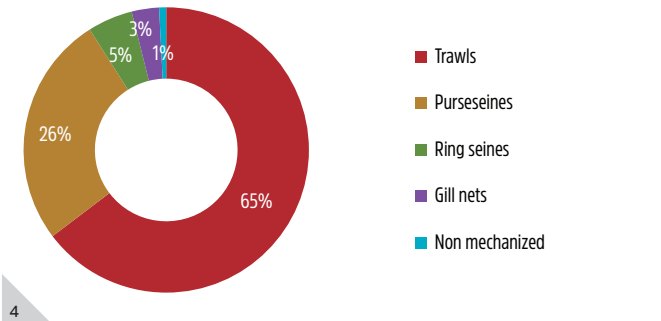

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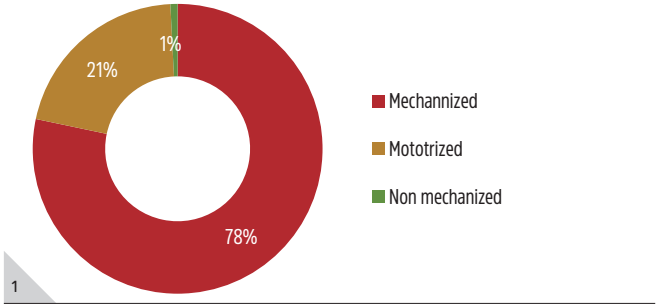
Sustainable management of fishery resources: Karnataka and Goa



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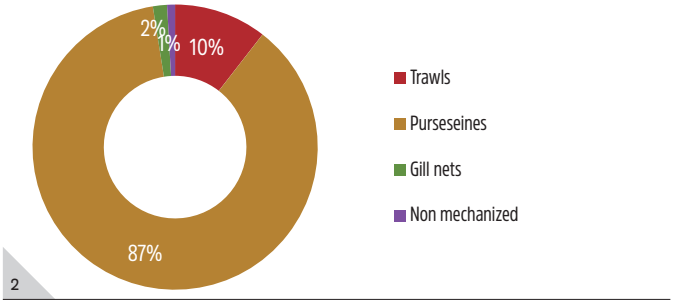

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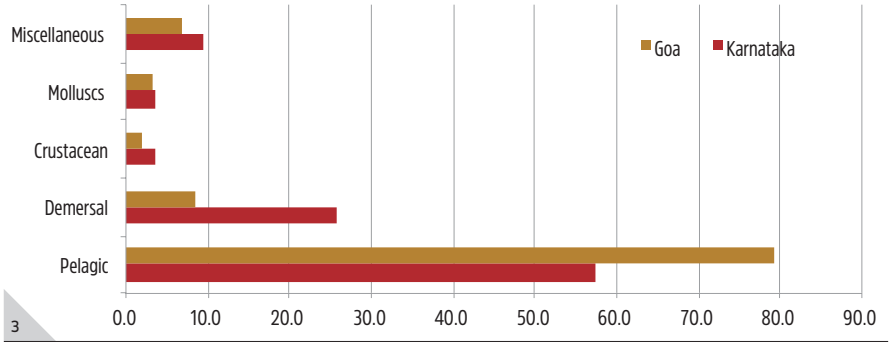

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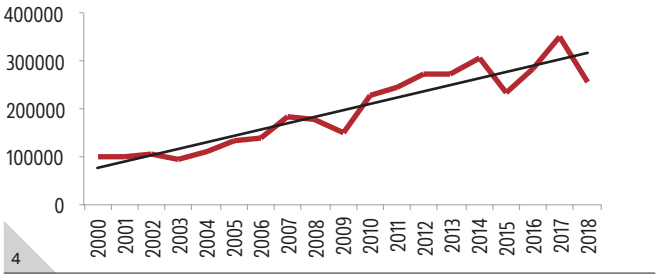
1. Contribution (%) of different sectors and gears to the total landings in Goa
2. Contribution (%) of different gears to the total landings in Goa
3. Contribution of (%) of pelagic, demersal, crustacean and molluscs in Karnataka and Goa
4. Annual trends and contribution (% of total) of pelagic fishes in Karnataka
5. Trends in landing of demersal fishes along Karnataka

al,2010).Trends in landing of major species compared to 2017 are given in figure 2. Pelagic fishes (2,55,769 t) forming 57.3% of the total landings in Karnataka recorded a decline of 26.9% as compared to 2017 and in Goa the catch (46,789t) formed 79.2%, a reduction of 41% as compared to 2017. Clupeids (Sardines, white sardine, shads and anchovies), Scombroids (mackerel, tuna and seerfish), Carangids (scads, horse mackerel, black pomfret and other carangids), ribbonfish, barracudas and fullbeaks were the dominant groups. An increase in the mean length of several pelagic fishes during the year was observed.

The demersal fishes (1,14,878t) formed 25.8% of the total catch in Karnataka and 5.6% (5069t) in Goa. The catch this year declined by 15% and 9% in Karnataka and Goa respectively as compared to the previous year. Perches (threadfin breams, bull's eyes, rockcods, and other perches), lizardfishes, croakers, soles, silverbellies, and big jawed jumpers were the dominant groups.



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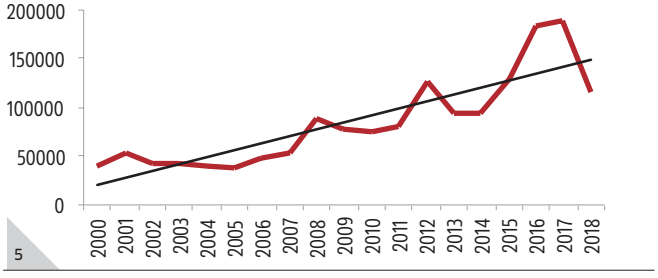

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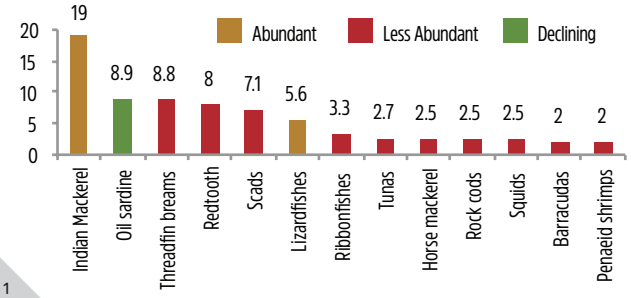
Table. 1. Length range, mean and Sex ratio of resources studied

Species	Length range (cm)	Mean (cm)	Sex ratio (Male:Fenale)
Fishes			
Pelagic fishes			
*S.longiceps**	9.0-20.4	17.5	**1**:1.13
*S.fimbriata**	8.4-21.2	10.5	**1**:1.15
*S.gibbosa**	13.1-19.1	16.3	**1**:1.62
*S. albella**	12.8-21.0	17.6	**1**:0.76
*S. brachysoma**	18.0-20.8	19.0	**1**:2.50
*R.kanagurta**	5.1-31.0	19.7	**1**:1.06
*T.lepturus****	4.0-54.0	25.0	**1**:1.20
*E.devisi**	4.5-14.5	8.6	**1**:0.98
*K. kovala**	7.5-12.6	11.5	**1**:1.14
*M. cordyla**	6.5-49.0	22.6	**1**:0.76
*D. russelli**	5.2-28.3	15.8	**1**:0.64
*S. nigrofasciata***	11.3-63.8	29.4	**1**:1.25
*R.canadum***	15.0-150.0	58.0	**1**:0.67
*S.commerson***	20.0-129.0	59.0	**1**: 1.24
*S. guttatus***	22.0-64.0	34.0	**1**:1.7
*E. affinis***	16.0-107.0	36.0	**1**:1.34
*A. thazard***	20.0-63.0	35.0	**1**:1.05
*A. rochei***	22.0-38.0	45.0	**1**:0.7
*T. tonggol***	38.0-67.0	71.0	**1**:0.5
*T. albacares***	66.0-80.0	42.0	**1**:0.9
*S. orientalis***	40.0-48.0	25.0	**1**:1.4
*S. obtusata***	12.0-37.0	22.0	**1**:1.5
*S. putnamae***	17.0-91.0	37.0	**1**:0.8
*S. jello***	20.0-13.0	38.0	**1**:0.5
*S. commersonianus***	20.0-113.0	47.0	**1**:0.64
*S. tol***	14.0-59.0	33.0	**1**:1.02
*S. tala***	21.0-69.0	38.0	**1**:1.7
*S.lysan***	24.0-69.0	45.0	**1**:4.0
*C. hippurus***	28.0-129.0	74.0	**1**:2.65
*A. hains***	52.0-127.0	87.0	**1**:2.25
*T. crocodilus***	48.0-143.0	97.0	**1**:2.0
*E. bipinnulatus***	45.0-54.0	47.0	**1**:3.0
Demersal fishes			
*N.japonicus**	3.0-35	13.0	**1**:0.8
*N.randalli**	3.0-32.0	12.2	**1**:0.8
*L. lactarius**	3.0-29.0	14.7	**1**:1.0
*P.argenteus**	6.0-43.0	21.5	**1**:0.9
*P.niger**	9.0-54.0	23.2	**1**:1.4
*L.inermis**	3.0-54.0	18.1	**1**:0.8
*O.cuvieri**	9.0-44.0	21.8	**1**:1.0
*O.ruber**	10.0-49.0	23.6	**1**:2.5
*S.tumbil**	3.0-58.0	26.1	**1**:2.8
*S.undosquamis**	3.0-45.0	19.0	**1**:1.5
*P.hamrur**	5.0-39.0	22.4	**1**:1.4
Crustaceans			
Shrimps			
*M.dobsoni**	5.1-12.5	8.6	**1**:1.11
*P.stylifera**	4.3-12.5	9.4	**1**:0.9
*M.monoceros**	7.1-18.5	12.4	**1**:0.9
Crabs			
*S.choprai**	4.1-11.0	8.7	**1**:1.3
*P.sanguinolentus**	4.6-13.0	9.0	**1**:2.9
*P.pelagicus**	3.1-16.0	8.5	**1**:1.78
*C.feriatus**	4.1-13.0	8.0	**1**:1.3
Cephalopods			
Squids			
U.(P.)duvauceli	3.5-35.0	9.5	**1**:0.9
U.(P.)singalensis	2.5-26.5	12.0	**1**:0.7
U.(P)edulis	2.0-30.5	10.9	**1**:1.0
Cuttlefish			
S.pharaonis	5.0-41.0	18.7	-
S.elliptica	2.0-14.5	8.0	**1**:1.7
S.inermis	5.0-41.0	18.7	**1**:1.2
Octopus			
A.neglectus	1.5-9.5	4.9	**1**:0.8

*Total length, **Fork length, ***Anal length, fo Cepahalopods-Mantle length

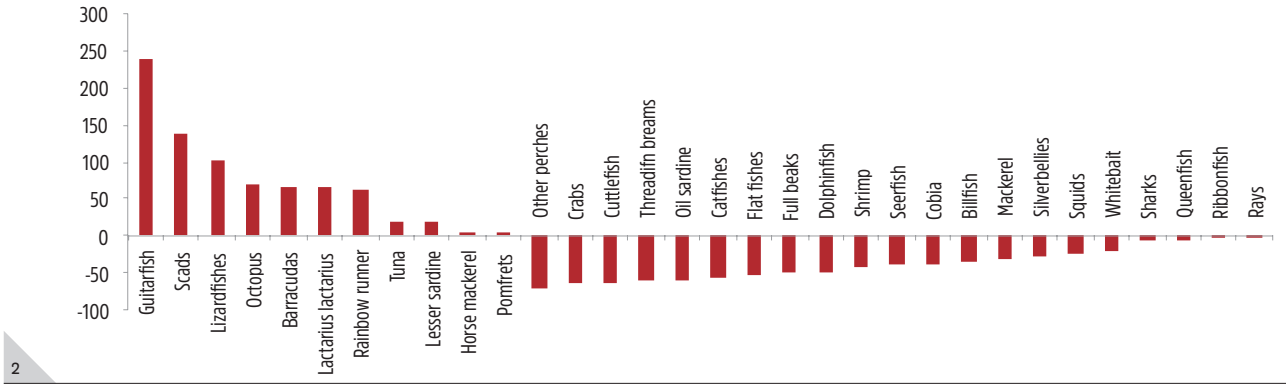
Sustainable management of fishery resources: Karnataka and Goa



1

The contribution of small sized fishes (below suggested Minimum Legal Size) of important species studied during the year ranged from 70% in cobia to less than 1% in ribbonfish, white sardine and oil sardine.

Crustaceans formed 3.6% (30,798 t) and 2.1% (1268 t) of the marine landings in



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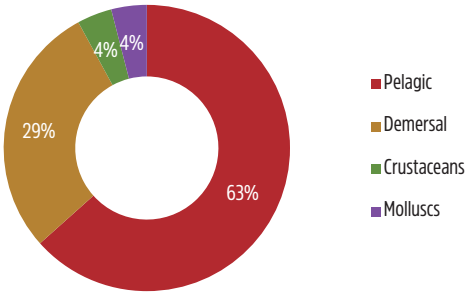

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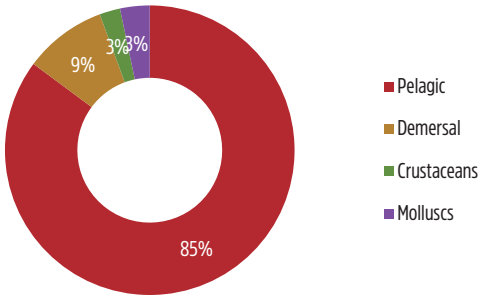

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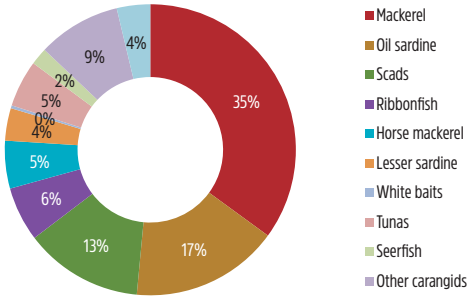

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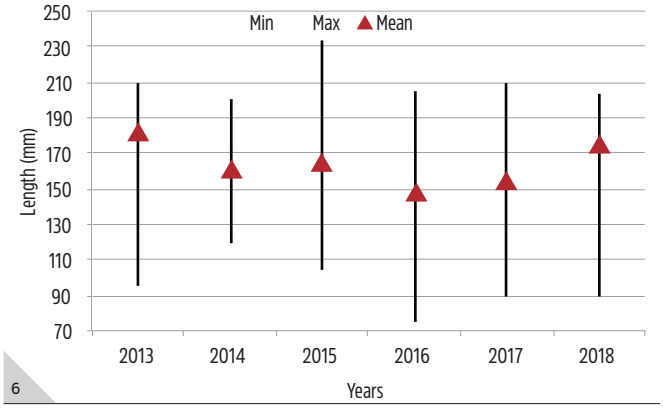
Karnataka and Goa and the landings this year is 49 and 34% less respectively as compared to last year. Shrimps (9005 t), crabs (2576 t), stomatopods (4247 t) and lobsters (2 t) contributed to the catch. Species composition of shrimps and crabs in Karnataka are given.

Cephalopods constituted by squids, cuttlefishes and octopus formed (26129 t) 3.6 % and (1815 t) 3.1% in Karnataka and Goa respectively. The catch this year recorded a decline of 38% in Karnataka

Sustainable management of fishery resources: Karnataka and Goa



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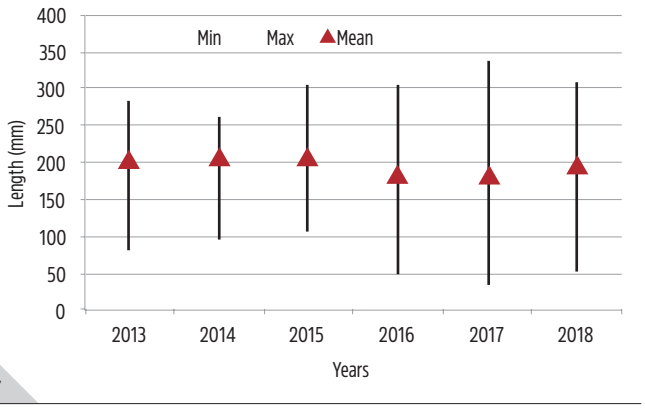

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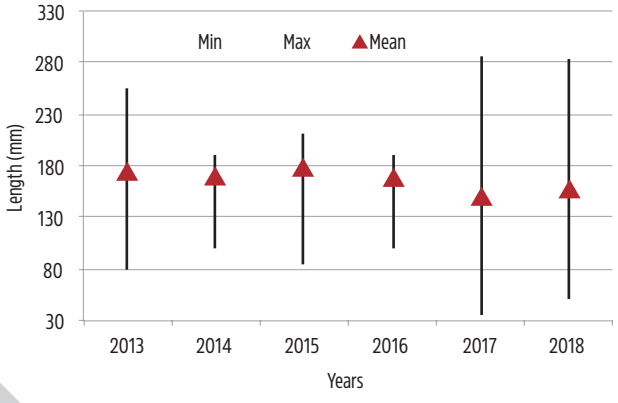

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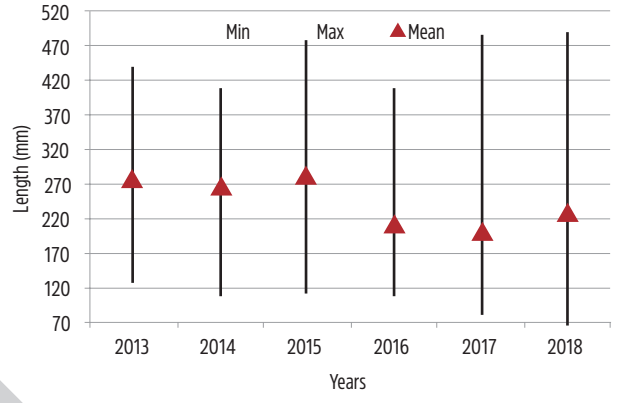
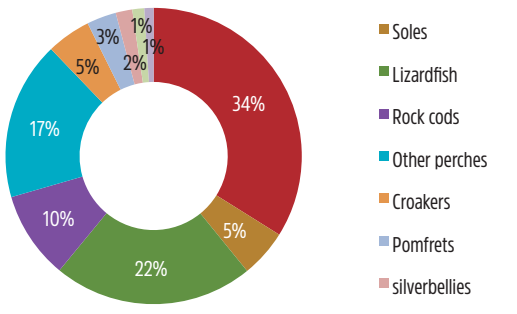


9

1. Contribution (%) an stock status of dominant species in Karnataka
2. Trends in landing of major resources in Karnataka as compared to 2017
3. Contribution (%) of pelagic, demersal, crustacean and molluscan resources to the total
4. Contribution (%) of pelagic, demersal, crustacean and molluscan resources to the total marine landings of Goa
5. Contribution of different resources to the total landings of pelagic fishes in Karnataka
6. Mean length of oil sardine
7. Mean length of Indian mackerel
8. Mean length of Indian scad
9. Mean length of horsemackerel
10. Major demersal (%) fishes landed in Karnataka



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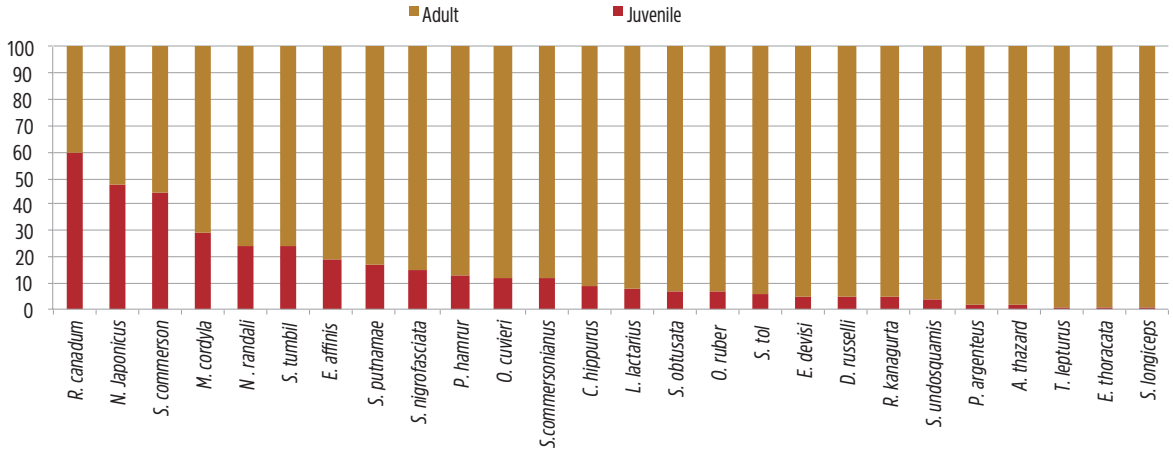
Sustainable management of fishery resources: Karnataka and Goa



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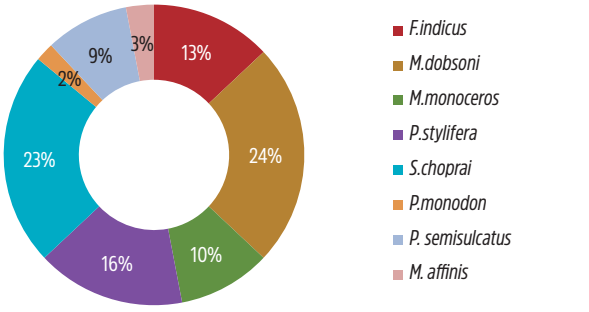

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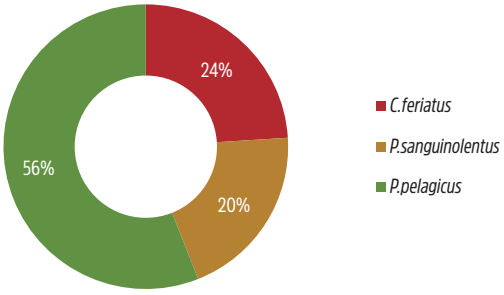

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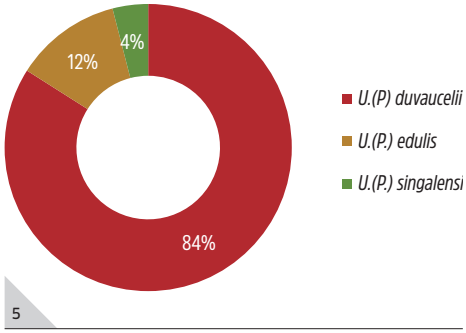
4

1. Composition (%) of juveniles and adults of pelagic fishes landed in Karnataka
2. Dominant species of shrimps landed in Karnataka
3. Dominant species of crabs landed in Karnataka
4. Traditional Gillnet boats fishing in Malpe
5. Contribution (%) of different species to the total squid catch in Karnataka
6. Contribution (%) of different species to the total cuttlefish catch in Karnataka
7. Contribution (%) of different species to the total Octopus catch in Karnataka
8. Flatfish landed by traditional craft during monsoon at Malpe

Sustainable management of fishery resources: Karnataka and Goa



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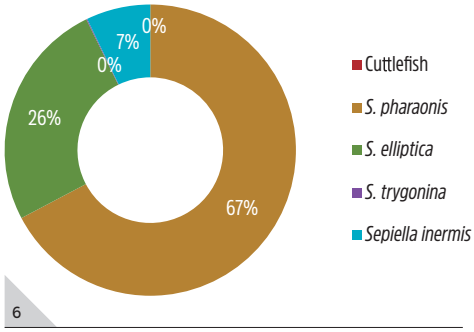

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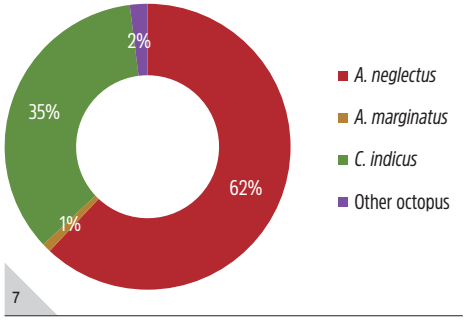

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and 287% increase in Goa as compared to the previous year. Squids dominated the cephalopod fishery with the three species contributing to the catch, followed by four species of cuttlefishes and four species of octopus in Karnataka.

Water quality parameters and productivity of inshore and in situ collections made at the fishing grounds were analysed and health of the sea off Karnataka was monitored regularly. Plankton blooms, pollution in coastal areas and stranding of mammals in the beaches off Karnataka were reported.

Cost and earnings data pertaining to mechanized trawlers, purse seiners and gillnetters were collected from Mangalore landing Centre of Dakshina Kannada District of Karnataka and the results provided.

A rapid survey of different stakeholders in the fishing sector was conducted to get an idea of the impact ofz the unusual bulk landings of the redtooth triggerfish along Karnataka Coast. Questionnaires were prepared and trawl boat owners, crew, unloading and loading workers, ice plant workers and owners of other boat categories were interviewed to get their perception on this unusual phenomenon in the fishery.

Table.2. Cost and earnings of mechanized trawlers, purse seiners and gillnetters operating at Mangalore Fishing Harbour, Karnataka

Particulars	Multi-day trawler	Purse-seine	Gillnetter
Total Operating costs (Rs.)	597026	288756	151139
Gross revenue (in Rs.)	671751	341820	213442
Net Operating income (Rs.) (7)-(6)	74725	53063	62303
Operating ratio (total operating cost/gross revenue)	0.89	0.84	0.71
Labor productivity (in kg) (catch/crew/trip)	1083	453	2564
Input-output ratio = (Input costs/gross revenue)	0.59	0.53	0.21

Kerala and Lakshadweep

Research project DEM/RMS/07 & DEM/RMS/SUB/07

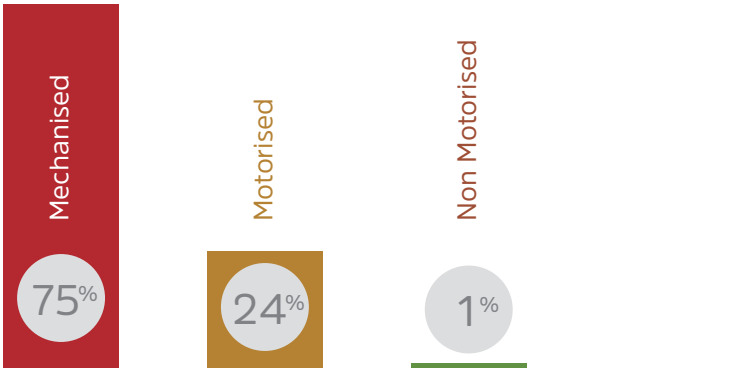
The total marine fish landings in Kerala during 2018 was 6,42,081 t which was 9.8% higher than that of the previous year (2017). About 74.7% of the catch was landed by mechanized gears and 24% by motorized units. The major resources in the catch was Indian mackerel (12.6%) followed by oil sardine (12%), threadfinbreams (8.3%), *Stolephorus* (8%) and penaeid shrimps (7.9%). Pelagic finfishes dominated the landings with a share of 62%, which was 6.1% higher

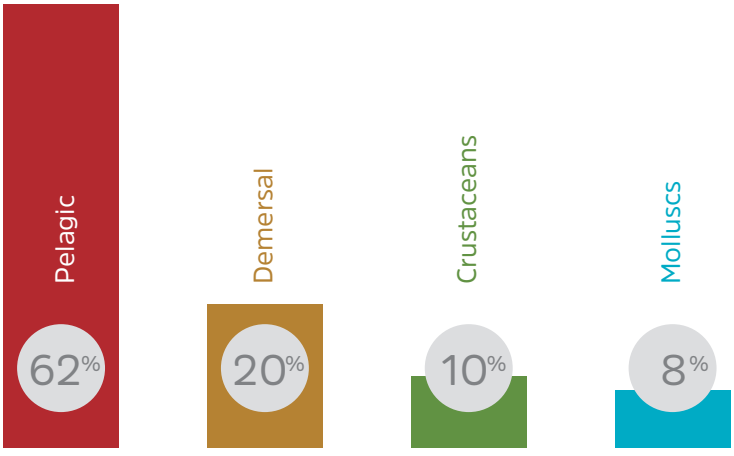
1. Landings of Indian mackerel at Cochin Fisheries Harbour

than that of the previous year's estimated pelagic catch. Demersal finfishes constituted 20% of the total marine fish landings of Kerala with estimated landings of 120,735 tonnes, which was 2.2% lower than that of the previous year's estimates.

There was a considerable decline in oil sardine fishery of Kerala with an estimated 77,093 t landed in 2018 compared to 2017. However, the mean size in the catch was 167 mm which was higher than the estimated length at first maturity of 147 mm and L_{opt} of 152 mm. Biological Reference Points indicated the SSB was 67% of the total standing stock. Exploitation rate was estimated at 0.5.

The landings of Indian mackerel showed nearly one and half fold increase with an estimated landing of 80568 (+142%). Fishery indicators showed that the mean size in the catch as 182 mm which was lower than the estimated length at first maturity of 190 mm and L_{opt} of 220 mm. BRPs indicated the SSB as 40% of the total standing stock. Exploitation rate was 0.63 indicating high fishing pressure. High recruitment was observed in July–August period.





Among the demersal finfishes, the dominant resource was threadfinbreams with annual landings of 53,548 t which formed 44.4% of the total demersal landings of the state, which was followed by other perches (13.4%), soles (12.7%) and lizardfishes (10.3%). 5% of the threadfinbreams landing was by trawlers and compared to previous year the catch showed 22.6% increase. Highest landings were noticed in August immediately after the trawl ban period. The major species in landing were *Nemipterus randalli* (54%) and *Nemipterus japonicus* (44%). The mean size of *N. randalli* was 151 mm. Mature individuals were present throughout the year with peak occurrence in September (90%), October (100%)andNovember (100%). 15,262 t of flatfishes was landed in Kerala**,** mainly by trawlers. *Cynoglossus macrostomus* was the major species with size range of 65 -190 mm

Estimated landing of lizardfishes was 11,795 t which formed 1.84% of the total marine fish landings of Kerala. Fishery occurred throughout the year with peak landings during June (17%). *Saurida tumbil* dominated with a contribution of 58% followed by *S. undosquamis* (40%). The annual mean length of *S. tumbil* was 355 mm and that of *S. undosquamis* 210 mm.

Elasmobranch landings declined by 49% in 2018, of which sharks contributed 51%, followed by rays (46%). More than 20 species of sharks were observed in the landings, of which *Carcharhinus falciformis* (45%) was the dominant species with an annual mean length of 135 cm. The mean length of *C. falciformis* and *C. amblyrynchoides* in the landings were considerably below their size at first maturity. There was a remarkable increase in the landings of the big jawed jumber (*L. lactarius*) compared to the previous year (237%).

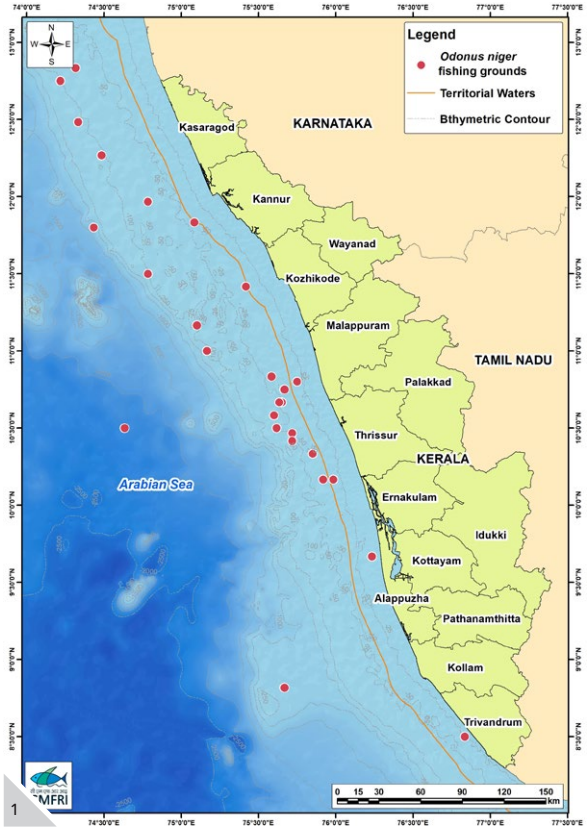
Sustainable management of fishery resources: Kerala and Lakshadweep

Crustacean resources contributed 10% of the total marine fish landings of Kerala with estimated landings of 64,840 tonnes, which was 20% higher than the previous year's estimates. About 77.8% was contributed by penaeid shrimps, followed by non-penaied shrimps (12.1%). Among the inshore shrimps *Metapenaeus dobsoni* was the dominant species in the landings forming 63.71% followed by *Parapenaeopsis stylifera* 23.5%, *Penaeus indicus* 3.8%, *Metapenaeus monoceros* 2.9% and *Trachypenaeus curvirostris* 1.8%. The average annual deepsea shrimp landings amounted to 13,000 t almost doubling the catch from the previous year, of which deepsea penaeids formed 48% and the non-penaeids contributed about 52%. *Plesionika quasigrandis* (30%) dominated the catch followed by *Heterocarpus chani* (22%), *Metapenaeopsis andamanensis* (17%) and *Aristeus alcocki* (16%).

The cephalopod landings of the state in 2018 was 43,212 t, of which 85% of the landings was contributed by multiday trawlers. Compared to last year, cephalopods catch increased by 16% with peak landings during August-September. Squids (54.5%) dominated the catch followed by cuttlefish (31%) and octopus (14.5 %). In case of major squid *U(P). duvaucelii,* the mean length was marginally below the optimum length of capture.

There was an unusual fishery for *Odonus niger* (red-toothed trigger fish-*klathi)* along the Kerala coast. High landings of the species was noticed during the IVth quarter mainly targeting fish meal/manure industry. Mean length in the catch was

1. Fishing grounds of Odonus niger along the coast of Kerala
2. Lizardfishes landed at Munambam Fisheries Harbour
3. Juvenile sharks landed at CFH ready for auction



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Economic loss due to juvenile fishing of some of the major resources in Kerala in 2017 and 2018.

Fish Groups	2017 (Rs. crores)	2018 (Rs. crores)
Threadfin breams	221.24	85.30
Squid	65.65	18.56
Lizardfishes	195.00	34.66
Groupers	14.11	3.25
Mackerel	-	114.12
Total	495.99	225.89

12 cm, all the samples were immature. Resource was caught all along the coast and sold at Rs.15-25/kg with a CPUE of 3-6 t/unit

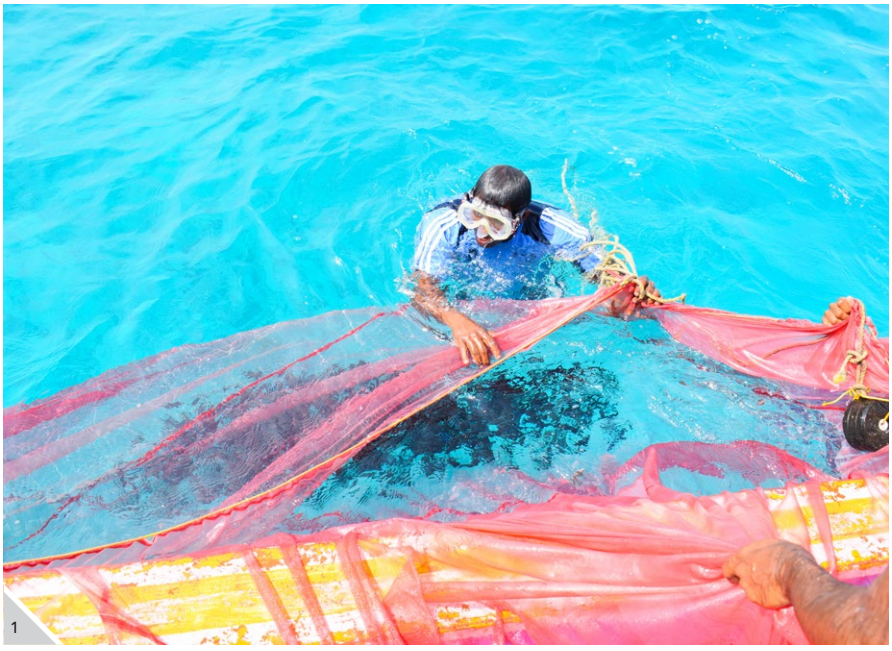
Variations in selected environmental parameters and chlorophyll, off Kochi along the Kerala coast were studied during 2018. The mean SST varied from 29.28 to 30.35°C in pre-monsoon and 28.67 and 29.11°C in the post monsoon. Mean salinity ranged from 32 and 34.71PSU in pre-monsoon and 30.11–34.93 PSU in post monsoon. The mean DO varied between 5.7 and 7.07 mg l^{-1} in the surface and between 5.27 and 6.70 mg l^{-1} in the bottom. The highest levels of nutrients (dissolved inorganic N, dissolved inorganic P and dissolved inorganic Si) in the surface waters showed higher values in pre-monsoon compared to post monsoon. Similar trend was seen for total chlorophyll (T chl) and total suspended solids (TSS) in surface waters. *A. Trichodesmium* sp bloom was observed during the month of April 2018 near to 30 m depth, off Kochi.

Implementation of MLS regulations along the Kerala coast has substantially reduced the harvest of juveniles of commercially important finfishes and shellfishes during 2018 compared to the previous year. However, there were incidence of juvenile harvest of the species *N. randalli* (33-43%) during the first and second quarters of the year and *R. kanagurta* (5-30%) during third quarter, mostly by motorized/inboard fishing units. The estimated economic loss was Rs.85 crores for *N. randalli,* Rs. 114 crores for *R. kanagurta.* There was high incidence of juvenile landings of *C. falciformis* and *C. amblyrhyncoides* along the Kerala coast during 2018, which are currently not included in the list of species under MLS regulations in the state. The estimated loss due to juvenile shark fishery was Rs. 61.4 crores. Spatial and temporal mapping of juvenile grounds off Kerala has been continued during the first and second quarters of the year. The species wise data were plotted in GIS platform to enable the resource maps to identify the juvenile grounds along the coast.

Among the mechanized fishing units operated along the coast of Kerala, the highest gross income (Rs.9.32 lakhs) and net operating income (Rs. 2.77 lakh) were recorded for Multiday trawl nets operated with high speed Chinese engine. The gross revenue realised by the multiday trawlers with high speed engines was Rs.931927 with a net operating income of Rs.2.77 lakhs The capital productivity declined for multiday trawlers with high speed engines and inboard ring seiners when compared to the previous year with operating ratios of 0.73 and 0.83 respectively

Lakshadweep

Research project PEL/LAK/06



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An in-house project titled "Resource assessment and management framework for sustainable marine fisheries of Lakshadweep" aimed at developing database for evolving science based fishery management plans (FMP) for the fisheries of Lakshadweep islands was initiated during the year 2017-18. The project, though in line with the FMP projects of CMFRI in other maritime states is distinct due to the lack of a permanent base of CMFRI in the islands. The project is operated with the support of the U.T. Administration, Department of Fisheries by deploying qualified and trained contractual research personnel attached with the Department of Fisheries in selected islands. Data on fishery, biology, economic, and social data on the fisheries of the islands were collected on a regular basis since April, 2018. Unlike in the other FMP projects, as the species wise catch and effort data is not collected by CMFRI under this project, the data collected by the Department of Fisheries, Lakshadweep were used wherever required. The research personnel appointed under the project were imparted orientation and training on the project objectives, technical programmes, collection and upkeep of the data on fishery, biology and socio-economics etc and were made familiar with the tools and techniques involved under different technical programmes with hands on experience.

Some of the important interventions/ observations/ deliverables made under the project during the year 2018-19 are detailed below.

Improvements in estimation of Fish Landing in Lakshadweep

The Department of fisheries, Lakshadweep have been collecting fish landing data from all the islands including the uninhabited islands and reef areas; where the fishermen camp for fishing. The data collection system of the Department was reviewed for its accuracy and practicality and found needing improvement. The department follow complete enumeration and the major lacunae in the current practice are the lack of fields for recording the fishing effort in the schedule, lack of species level data and practical difficulty to cover every fishing unit landed throughout day/night across the island by limited enumerators etc. Landing data of the uninhabited islands and reef areas is another big concern. The project has taken a two pronged approach to overcome this problem. The Department of Fisheries will be assisted to overcome the deficiencies in the current methodology immediately through revision of schedule and training of enumerators; and develop and pilot a suitable methodology for collecting data more accurately in the typical context of the islands' fisheries.

Long-term database on biology and fisheries

Organised data collection on biological aspects of the island fisheries have begun since April, 2018. Due to the constraints of manpower, the studies are mainly based at Agatti and Kavaratti islands now. The study area is being expanded to Minicoy and Androth islands in the current year. Periodic samples are drawn from the fishery following the random sampling protocol and analysed. There is a working arrangement with the Department of Fisheries, Lakshadweep for carrying out such studies in their premise. Vessel based

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1. Live bait (trigger fish) collection from the outer reef area for yellofin handline fishing
2. Red tooth trigger fish (*Odonus niger*), major live bait species used for chumming in yellowfin handline fishing
3. Lainching of the Lakshadweep FMP Project by the Director, CMFRI
4. Stakeholder consultation at Kavaratti island for the Lakshadweep Livebait Fisheries Managment Plan

studies are also carried out regularly for recording information on the catch, bycatch, discard, spatial information etc. of bait fisheries as well as tuna fisheries. The database is important for scientific assessment of the island fisheries.

Livebait Fisheries Management Plan

Lack of management plan for the livebait fisheries have been identified as a major shortcoming in the skipjack tuna pole and line fisheries of Lakshadweep in the pre-assessment of the Marine Stewardship Council (MSC) and has been identified as the key point to address in the Fisheries Improvement Project (FIP) coordinated by the World Wildlife Fund (WWF)-India. Being the major knowledge partner in the MSC certification process, the CMFRI took up formulation of Livebait Fisheries Management Plan. The Plan formulated after peer consultations has been finalised after consultation with the stakeholders of Lakshadweep skipjack tuna pole and line fisheries in the presence of experts from other organisations like the International Pole and Line Foundation, WWF-India etc. The Plan isbeing submitted to the Administration for formalisation.

Emergence of Handline fisheries with live chumming for yellowfin tunas

Yellowfin tuna had been gradually emerging as an important fishery in the islands. Landing of the species has been increasing steadily for the past years and the landing steeply increased in the last three years. Though an abundant resource around the islands, the yellowfin was not targeted principally due to marketing concerns. The Department of Fisheries' initiatives for permitting the local residents to deploy larger fishing boats leased out from mainland for collecting catch from the local fishers and marketing in the mainland have triggered the sudden emergence of the fishery in almost all islands.

Tamil Nadu and Puducherry

Research project PEL/RMS/08

The total marine landing in Tamil Nadu in 2018 was 7.02 lakh t showing an increase of 7% when compared to previous year. The maximum contribution was from Kanyakumari District (28.4%) followed by Ramanathapuram (20.8%), Nagapattinam (13%) and Tuticorin (10.1%). Mechanized trawls were the dominant gears with single day mechanized trawls contributing 48.7% of the total landing followed by multiday trawlers (20.4%). The other major contribution was from motorized gillnet (13.4%). Pelagic finfishes formed 52.1%, demersal fin fishes 33%, crustaceans and cephalopod 7.5% each.

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Sustainable management of fishery resources: Tamilnadu and Puducherry

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1. Carrier boats with fishes at Cuddalore
2. Billfish being unloaded to tricycle-Chennai
3. Octopus landing-Chennai

Percentage status of major resources in 2018 comapared to 2017

	Increase	Decrease
Carangids	261.3	
Tunnies	95.3	
Elasmobranchs	55.4	
Ribbonfishes	53.7	
Mackerel	40.3	
Other perches	11.1	
Penaeid shrimps	5.5	
Catfishes		31.6
Oil sardine		47.8
Lesser sardines		15.1
Whitebaits		20.3
Croakers		21.4
Silverbellies		15.7
Pomfrets		17.3
Seerfishes		25.2
Cephalopods		14.8

Sustainable management of fishery resources: Tamilnadu and Puducherry

Length composition of major pelagic resources from Tamil Nadu

Species	Min(cm)	Max(cm)	Mean(cm)
S. gibbosa	8	`17	12.5
S. longiceps	6	17.5	12.5
A. sirm	13.5	19	16.2
D. macrosoma	13	19.5	15.5
D. russeli	12	16	14.5
S. crumenophthalmus	12.5	28	21.2
A. mate	15	24	20
C. malabaricus	11.5	20.5	15.1
C. armatus	14.5	22	18.9
C. sexfasciatus	12.5	20.5	18.5
U. uraspis	17	24.5	20.7
S. indicus	4.5	14.5	10.7
S. commersoni	9.5	12.5	11.4
E. devisi	5.5	9.5	8.3
R. kanagurta	10.5	26.4	22.5
R. faughni	11	22	18.5
T. albacares	34	158	65.5
K. pelamis	32	76	55.4
E. affinis	18	54	43.1
A. thazard	22	42	30.8
A. rochei	20	30	24.1
I. platypterus	90	250	150.6
X. gladius	60	230	112.6
I. indica	85	270	192.8
S. commerson	28	71	45.4
S. guttatus	39	41	40.3
Sphraena putnamae	36	110	56.7
S. obtusata	20	2	24.1
S. forsteri	18	26	22.5
S. jello	19	27	23.1
R. canadum	34	69	45.5
T. lepturus	33.5	89.4	62
R. canadum	20	104	59
S. leptolepis	8	19	12.7
A. clupeoides	11	23	19
A. sirm	14	21	17.2
S. leptolepis	6	17	11.7
S. longiceps	12	20	16.3
R. kanagurta	11	23	16.6
S. putnamae	34	74	52.6
S. albella	8	15	11.5
S. gibbosa	9	16	12.3
S. obtusata	12	38	23.1
S. commerson	10	112	34
C. heberi	10	29	18.6
L. savala	16	32	22.3
S. commersonianus	17	35	30.5
S. tala	17	22	18.7

Length composition of major demersal resources from Tamil Nadu

Species	Min	Max	Mean
Nemipeterus japonicus	12	27.9	18.1
Upeneus sulphureus	10	16.9	11.6
Lutjanus ehrenbergii	21	29.9	24.3
L. fulviflamma	13	26.9	19.2
L. lutjanus	10	28.9	14.5
L. quinquilineatus	8	23.9	12.9
Parastromateus niger	12	32.9	19.4
Psettodes erumei	10	56.9	27.3
Saurida micropectoralis	15	39.9	25.9
Otolithes ruber	12	33.9	20.4
Nibea maculata	7	22.9	13.6
P. indicus	12.3	31.1	19.8
L. lentjan	14.1	40.5	22.96
E. malabaricus	19	83	39.6
G. minuta	1.8	15	9.49
E. lineolatus	1.7	13	10.01
N. bipunctatus	12.5	31.2	22.14
G. minuta	10	15	11.49
K. dussumiera	9	15	11.21
L. quuinquelineatus	11	22	17.3

Puducherry: The total landing in Puducherry was 45406 t showing an increase of 68% when compared to previous year. MDTN contributed 86.7% and MTN 3.6% of the total landing which together formed 90%. The pelagic resources formed 30.5%, demersal 27.2%, crustaceans 17.7% and cephalopod 22.2%.

In the total landings in Tamil Nadu, though there were drastic decrease in the otherwise dominant resources like lesser sardines, oil sardine, silverbellies etc, the substantial increase in carangids, mackerel, ribbonfishes,penaeid shrimps etc resulted in an overall increase in the total landing. The oil sardine landing this year was 26991 t which was around 49% less than last year. Major districts of availability and season in both the years were almost similar but

Sustainable management of fishery resources: Tamilnadu and Puducherry

Length composition of shrimp resources from Tamil Nadu

Shrimps	Min	Max	Mean
Aristeus alcocki	7.1	19.5	12.9
Heterocarpus chani	9.6	11	10.3
Megokris granulosus	4.6	10.5	7.7
M. sedili	4.6	10	7.5
Metapenaeopsis andamanensis	5.1	10.5	7.9
M. coniger	4.6	10	7.7
M. gallensis	5.1	10.5	7.2
M. hilarula	4.6	8.5	6.4
M. mogiensis	4.1	9.5	6.8
M. novaeguinea	6.1	10	7.3
M. stridulans	5.1	10	7.5
M. toloensis	5.8	11	7.9
Metapenaeus affinis	6.6	18	12.8
M. alcocki	6.6	10	8.6
M. brevicornis	10.1	12.5	11.2
M. dobsoni	2.6	11.5	8.6
M. ensis	6.1	19	13.2
M. krishnatri	6.6	9	8
M. lysianassa	9.1	9.5	9.3
M. monoceros	5.1	20.5	11.9
M. moyebi	5.6	13	8.1
Parapenaeopsis acclivirostris	4.6	5.5	5.1
P. hardwickii	5.1	11	8.3
P. maxillipedo	5.1	12.5	8.4
P. stylifera	5.6	12	9.2
P. uncta	6.6	14.5	11.1
Parapenaeus longipes	5.1	8.5	6.9
Penaeus canaliculatus	9.1	20.5	14.3
P. indicus	7.6	22	13.7
P. japonicus	9.1	24	16.9
P. latisulcatus	9.6	18.5	14.7
P. merguiensis	12.3	19	15.2
P. monodon	9.6	27	14.6
P. penicillatus	12.1	16	14.1
P. semisulcatus	6.6	23.5	16.2
Solenocera choprai	6.1	11	8.1
S. crassicornis	3.6	10.5	8
S. hextii	6.1	8.5	7.2
S. koelbeli	6.1	10	7.8
Trachysalambria aspera	4.6	10.5	7.4
T. curvirostris	5.1	9.5	7.8

Shrimps	Min	Max	Mean
P. semisulcatus	8.1	28.1	14.97
P. semisulcatus	3.6	27.1	13
P. latisulcatus	4.1	23.1	15.2
P. latisulcatus	11.1	23.1	15.7
P. stylifera	1.1	13.1	9.68
P. canaliculatus	14.6	23.1	17.49
M. monoceros	7.6	29.1	13.97
P. merguiensis	5.1	29.1	14.6
P. monodon	9.1	28.1	21.25
P. indicus	9.1	23.6	15.1
P. japonicus	12.1	23.1	18.01
Aristius alcocki	3.1	19.1	11.85
Heterocarpus chani	1.1	13.6	9.83
P. Maxillipedo	5.6	11.1	8.25
M. stridulans	1.9	10.1	6.96
M. dobsoni	1.1	12.6	8.15
M. tolensis	2.1	11.6	8.1
M. lysinassa	5.6	8.6	6.77
N. tenuipes	6.1	12.6	8.17

Length composition of shrimp resources from Tamil Nadu

Crabs	Min	Max	Mean
P. gladiator	3.6	9.6	6.9
P. sanguinolentus	3.8	16.3	9.6
C. lucifera	4.3	9.8	7.11
C. granulata	3.8	8.1	5.88
P. pelagicus	6.3	17.3	10.94
C. feriatus	4.8	14.3	9.13
Galene bispinosa	4.3	8.8	6.15
P. pelagicus	10	19	16.1

Length composition of cephalopod resources from Tamil Nadu

Cephalopods	Min	Max	Mean
U (Photololigo) duvaucelii	3	18	8.8
U (P). singhalensis	7.5	24	11.9
Sepia pharaonis	4.5	32	14.5
S. aculeata	5	10.5	7.7
S. brevimana	2.6	9.8	6
Sepiella inermis	3	9.2	5.7
S. prashadi	5.5	12.5	8.1
Octopus dollfusi(Tl)	12.5	48.5	26.1
O. membranceus(TL)	11.6	30	19.6
Sepia pharaonis	7.9	37	22.1
Sepia ramani	8.7	38.1	23
Sepia prabahari	6	16.5	10.1
Sepia prashadi	5.8	15.9	7.9
Uroteuthis(P)duvaceli	6.6	32	13.3
Uroteuthis(P)singhalensis	4.4	31.5	14
sepiotuethis lessoniana	8	38	17.8
Amphioctopus aegina	4	19	8
Amphioctopus neglectus	2.3	11.7	6.9
Octopus cyanea	7	26.2	16.5
Sepia pharaonis	11.5	43	25.7
Sepiotuethis lessoniana	11	35.5	19
Octopus cyanea	5	22	9.9

Sex ratio of major pelagic fishes from Tamil Nadu

Species	Sex ratio(M=1)
S. gibbosa	1.5
S. longiceps	1.3
A. sirm	1
D. macrosoma	0.3
D. russeli	1.1
S. crumenophthalmus	0.9
A. mate	0.9
C. malabaricus	0.6
C. armatus	1.1
C. sexfasciatus	0.3
U. uraspis	0.9
S. indicus	0.4
S. commersoni	0.8
E. devisi	0.7
T. albacares	0.5
K. pelamis	0.9
E. affinis	1.6
A. thazard	1.2
A. rochei	1.7
R. kanagurta	1.6
R. faughni	1.3
T. lepturus	1.4
S. commerson	1.5
S. guttatus	2
Sphraena putnamae	1.5
S. obtusata	1.6
S. forsteri	1.7
S. jello	1.3
R. canadum	1.2
S. longiceps	2.2
S. gibbossa	2.2
S. albella	1.9
Amblygaster sirm	3.9
A. clupeiodes	2.4
S. indicus	1
R. kanagurta	0.6
S. longiceps	1.2
R. kanagurta	0.7

there was considerable reduction in the abundance. Mechanized single day trawlers were the major contributor recording 48% followed by outboard motor operated gillnet (25%). Out board motor operated ring seine contributed around 15% only. The lesser sardines decreased from 110000 t in 2017 to 94000 t in 2018. The silverbelllies also decreased from 76 000 to 64000 t in 2018.

But carangid landing increased from 48000 t in 2017 to 80000 t in 2018, tunas from 18000 to 35 000 t and mackerel from 22000 to 33 000 t. The

Sex ratio of major demersalfishes from Tamil Nadu

Species	Sex ratio (M=1)
Nemipeterus japonicus	4
Upeneus sulphureus	2.3
Lutjanus ehrenbergii	1.5
L. fulviflamma	1
L. lutjanus	2.7
L. quinquilineatus	3.9
Parastromateus niger	5.2
Psettodes erumei	1.1
Saurida micropectoralis	0.5
Otolithes ruber	0.8
Nibea maculata	1.1
P. indicus	1.4
L. lentjan	1.4
G. minuta	1.3
E. lineolatus	0.96
N. bipunctatus	1
S. bimaculata	4.6
L. quinquelineatus	1.5
K. dussumieri	2
G. minuta	2.2

Sex ratio of major shrimps from Tamil Nadu

Species	Sex ratio (M=1)
Aristeus alcocki	1.4
Megokris granulosus	1.3
M. sedili	1.3
Metapenaeopsis andamanensis	1
M. coniger	1
M. gallensis	1.1
M. hilarula	1.2
M. mogiensis	1.1
M. novaeguinea	0.9
M. stridulans	1.1
M. toloensis	1.1
Metapenaeus affinis	1.1
M. alcocki	1.1
M. brevicornis	1.1
M. dobsoni	1.1
M. ensis	1.1
M. krishnatri	1.1

Species	Sex ratio (M=1)
M. monoceros	1
M. moyebi	1.2
P. hardwickii	1.2
P. maxillipedo	1.2
P. stylifera	1.1
P. uncta	1.4
Parapenaeus longipes	1.3
Penaeus canaliculatus	1.1
P. indicus	1
P. japonicus	1.2
P. latisulcatus	1.3
P. merguiensis	1
P. monodon	1
P. penicillatus	0.9
P. semisulcatus	1.1
Solenocera choprai	1.2
S. crassicornis	1.2
S. hextii	1.1
S. koelbeli	1.1
Trachysalambria aspera	1.3
T. curvirostris	1.3
P. semisulcatus	1.3
P. semisulcatus	1.2
P. latisulcatus	1.6
P. latisulcatus	1.3
P. stylifera	0.8
Aristius alcocki	4.2
Heterocarpus chani	3.2
P. Maxillipedo	3.5
M. stridulans	1.3
M. dobsoni	1.3
M. tolensis	0.8
M. lysinassa	2.4
N. tenuipes	2.5

Sustainable management of fishery resources: Tamilnadu and Puducherry

1

Sex ratio of majorcrabs from Tamil Nadu

Species	Sex ratio(M=1)
Crabs	Sex ratio
P. gladiator	0.5
P. sanguinolentus	1.1
C. lucifera	0.7
C. granulata	0.8
P. pelagicus	0.9
C. feriatus	1.4
Galene bispinosa	0.5

Sex ratio of majorcephalopods from Tamil Nadu

Species	Sex ratio(M=1)
U (P) duvaucelii	0.3
U (P). singhalensis	0.3
Sepia pharaonis	0.4
S. aculeata	0.3
S. brevimana	10
Sepiella inermis	0.3
S. prashadi	0.2
Octopus dollfusi(TI)	0.2
O. membranceus(TL)	0.2
S. prabhahari	0.8
U(P) duvauceli	1.1
U. (P) singhalensis	1.5
S. lessoniana	1.3

Sustainable management of fishery resources: Tamilnadu and Puducherry

1. Deep sea shrimps- Chennai
2. Deep sea multiday ring seiner for oceanic tunas-Cuddalore
3. Tricycles with tunas waiting to be unloaded to the company- Chennai.


2


3

penaeid shrimp landings also similarly increased to 24400 t in 2018 from 23000 t in 2017 and this increase was mainly due to the increase in deepsea shrimp landing.

There was substantial increase in the effort of mechanized gears except single day trawlers compared to 2017. Another important development was operation of deepsea multiday ring seiners for oceanic tunas in 2018.

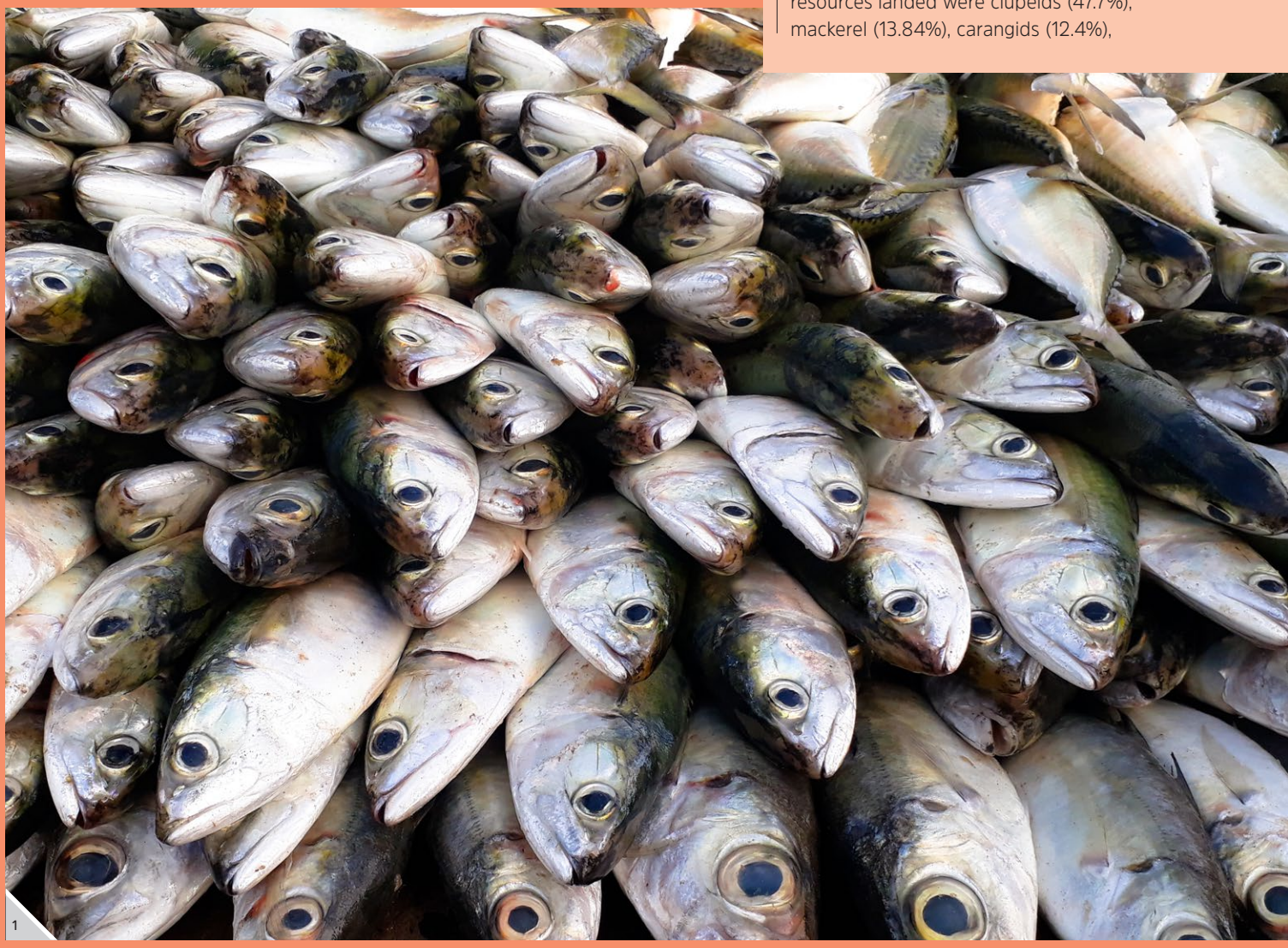
Biology: The mean sizes of majority of the finfishes and shellfishes were above the mean legal size though the minimum size of exploitation was found to be below the MLS in majority of the cases. Sex ratio indicated predominance of females in fishes and shrimps whereas males dominated in crabs and cephalopods. The percentage of spawning stock biomass (SSB) in standing stock biomass of dominant demersal fishes off Chennai showed that the SSB is within safe level for majority of the species.

Andhra Pradesh

Research Project: DEM/RMS/10

The marine landings of Andhra Pradesh were 1.92 lakh t in 2018. There was a decline of 3.6% in marine landings of the state from 2018 to 2017. The marine landings of the state have been in constant decline since the peak landings of 2014.

Pelagic fishes were the dominant resource followed by demersal, crustaceans and molluscans. Lesser sardines dominated by weight accounting for 17.8% of the total fish landed. Among pelagics, major resources landed were clupeids (47.7%), mackerel (13.84%), carangids (12.4%),



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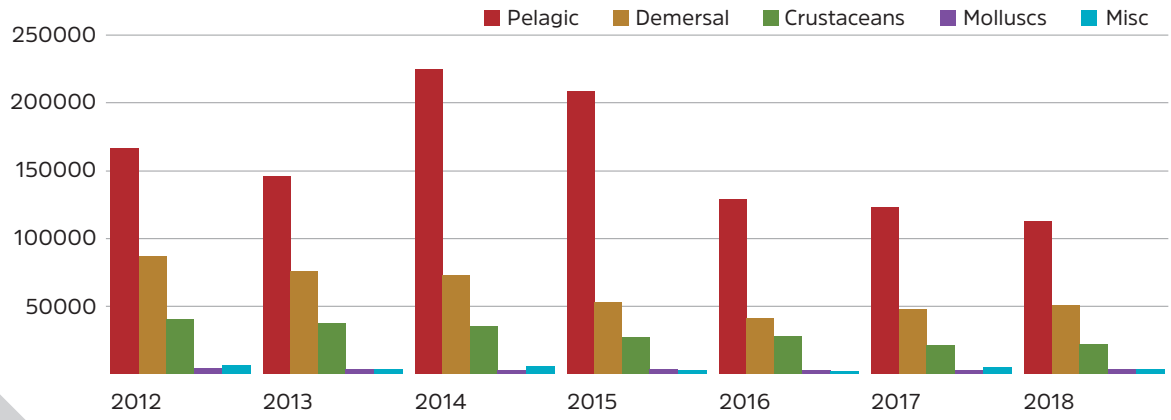
Sustainable management of fishery resources: Andhra Pradesh



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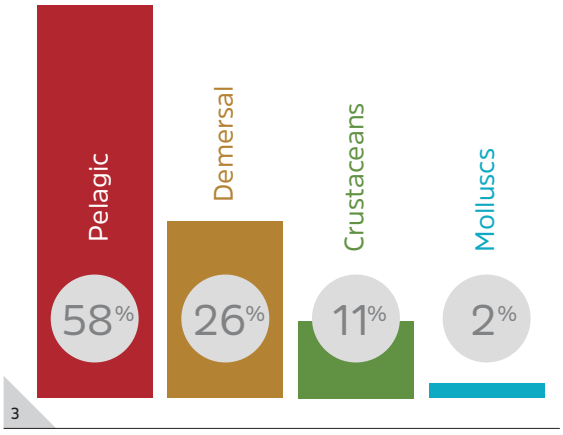

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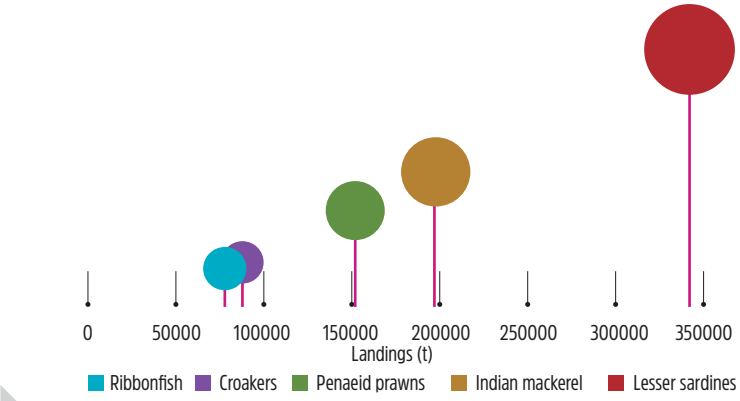

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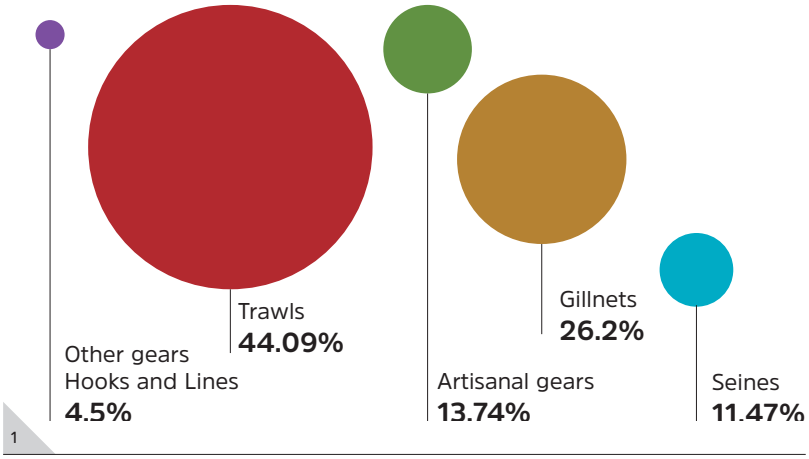
1. Indian mackerel landed at Visakhapatnam, AP
2. Decline in marine landings of Andhra Pradesh from 2014 to 2018
3. Contribution of major resource groups to marine landings of Andhra Pradesh in 2018
4. Top landed marine species in Andhra Pradesh in 2018

ribbonfish (7.25%), tunas (6.3%) and seerfish (3.15%). Barracuda and billfish contributed 2.49% and 1.6%, respectively. The major demersal resources were croakers (17.8%), other perches (10.2%), goatfish (9.9%), threadfinbreams (8.9%) and catfish (8.6%). Crustacean landing was contributed by penaeid shrimps (68.9%), non-penaeid shrimps (2.8%), crabs (27.4%), lobsters (0.2%) and stomatopods (0.7%). The major molluscan resources were the cephalopods comprised of the cuttlefishes (76.44%) and squids (23.56%).

Major fishing gears of Andhra Pradesh

Trawls were the major fishing gear of Andhra Pradesh in 2018 contributing 44.09% of marine landings. The catch-per-hour in trawls was 23.1kg/h. The highest catch rate however was seen in gillnets which caught 969.6 kg/unit, followed by seines (341.4 kg/unit) and hooks and lines (107.6 kg/unit).



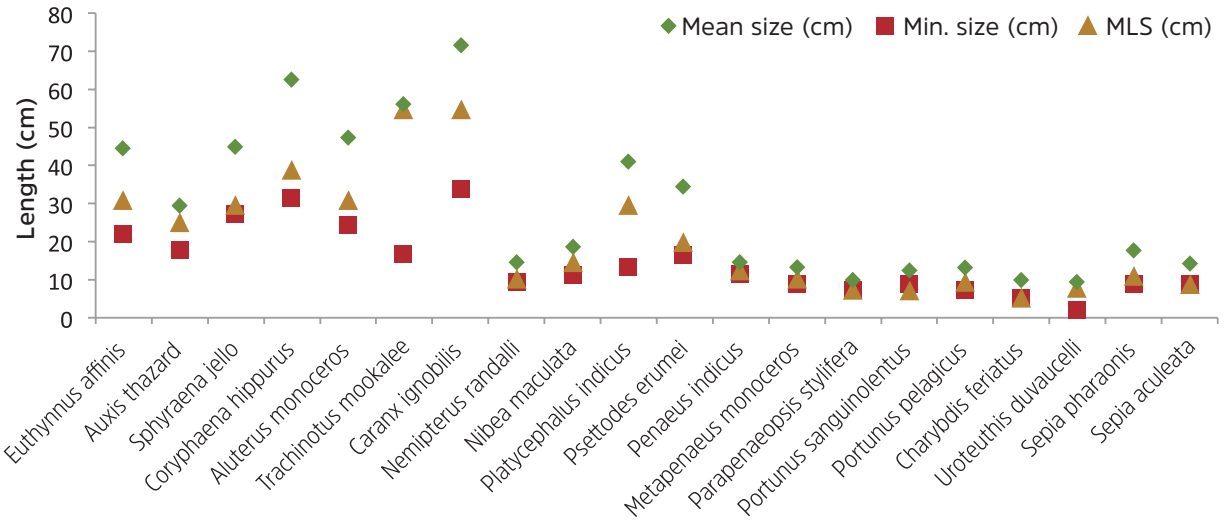
Biology of major species of finfish landed in Andhra Pradesh

Species	Length Range (mm)	Mean Length (mm)	Sex Ratio	Major Prey
E. affinis	220-639	445.75	1.6	Sardines, Squid, Squilla, Acetes
A. thazard	180-399	295.82	1.2	Penaeid shrimps, Squid, Crab larvae
S. jello	280-959	451.37	1.49	Sardines, Stolephorus, Clupeids, Mackerel, Carangids, Squids, Nemipterids, Sciaenids, Lizardfishes
C. hippurus	320-1059	624.38	2.21	Carangids, Mackerel, Juvenile tuna, Flying fishes, Sardines, Stolephorus, Ribbonfish, Squid, Crab
A. monoceros	240-659	477.1	1.2	Nemipterus, Apogon, Squilla, Gastropod, Squid, Sciaenids, Stolephorus, Leiognathus, Acetes, Penaeid shrimps
T. mookalee	168-833	566.0	0.6	Gastropods, crabs, shrimps, bivalves
C. ignobilis	340-1005	716.0	2.0	Teleosts, Crabs
P. kaakan	184-555	377.0	1.3	Fish, shrimps, crabs
D. punctata	158-417	303.6	0.9	Fish, stomatopods, shrimps
D. longimana	180-345	253.5	2.2	Fish, stomatopods, shrimps

Biology of major species of shellfish landed in Andhra Pradesh

Species	Length Range (mm)	Mean Length (mm)	Sex Ratio
P. indicus	115-225	149.9	0.9
M. monoceros	82-235	132.8	1.1
S. crassicornis	55-122	92.7	1.1
P. stylifera	76-135	99.8	1.5
P. sanguinolentus	79-200	126.4	1.36
P. pelagicus	75-175	131.5	0.4
C. feriatus	55-124	96.82	3.14
C. lucifera	55-126	87.1	1.2
S. brevimana	33-96	72.1	1.37
S. prashadi	45-114	80.7	0.87
S. inermis	33-107	61.9	1.53

Sustainable management of fishery resources: Andhra Pradesh



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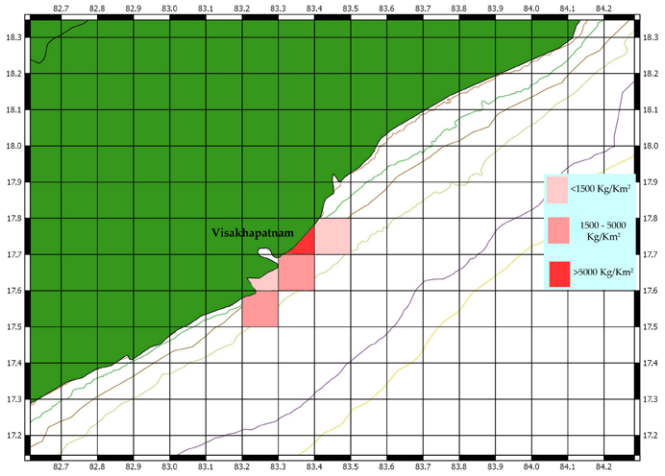

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1. Contribution of major fishing gears to marine landings of Andhra Pradesh
2. Mean size and minimum size of major commercial marine species in relation to MLS
3. Estimates of biomass per unit area from experimental trawling off Visakhapatnam during 2018-19; each grid measures 0.1 degree by 0.1 degree

Biology of major marine species landed along Andhra Pradesh

Studies were conducted on reproductive biology and diet of major finfish and shellfish species landed along Andhra Pradesh coast. The mean size of all the species studied was above the recommended Minimum Legal Size (MLS).

Experimental trawling off Visakhapatnam

A total of 24 experimental fishing trips were conducted off Visakhapatnam during 2018. The total catch in kg per trip ranged from 7 to 300. The average catch per trip was 77.6 kg. The average catch rate (kg/h) was 58.5. The major fish groups caught were ribbonfish, silverbellies, goatfish, threadfin breams and croakers. Average catch estimates per 0.10° × 0.10° grid ranged from 1081 – 9906 kg/km^2 and the average biomass estimates ranged from 2162-19812 kg/km^2.


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Marine environment

Debris along the seafloor was collected during the experimental trawling trips of 2018-2019. From this a ratio of fish weight to debris weight was estimated. The average fish to debris ratio off Visakhapatnam was 0.035. The highest value was seen in June just after the trawl ban ended along the Andhra Pradesh coast.

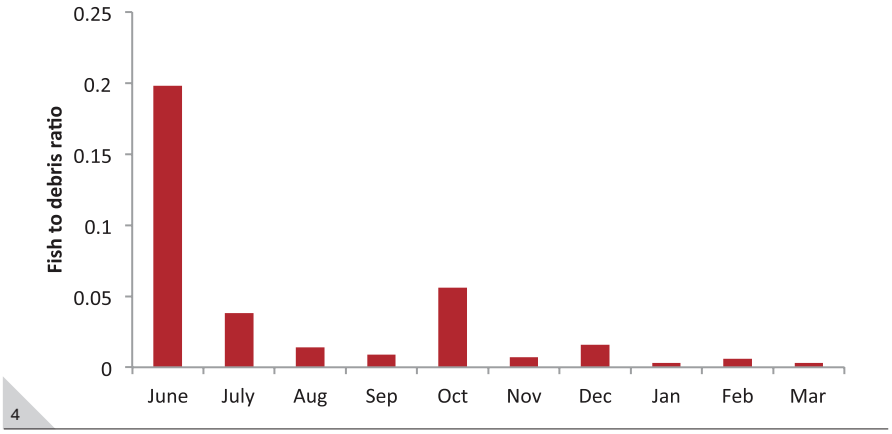
Impact of *Titili* Cyclone on Marine Fisheries of Srikakulam District of Andhra Pradesh

Srikakulam District is located in the extreme northeast of A.P. state. Fishing is a major occupation as well as a good source of healthy food for the coastal people of Srikakulam District. The *Titili* cyclone during 11th October 2018 had a major impact on fishermen's lives in the district. A study was undertaken to assess the impact of cyclone on marine fisheries of Srikakulam District of Andhra Pradesh. The respondents had enormous losses including property loss, displacement from dwelling, 24 days of employment loss and some of them experienced human loss due to cyclone. The loss incurred for fish farming was about Rs.10, 400. Most of the respondents faced health issues like typhoid fever, cold, cough and related ailments during the cyclone. It was found that an average of Rs 15,338 was incurred to meet medical expenses. Most of the fishermen participated in the relief activities. Around five people have been saved per boat in different turns and a total of 63 people were saved. But, the fishermen who were involved in the rescue process did not receive any remuneration or government support for the relief activities. Based on the survey conducted and the discussions with the affected people, the following measures are suggested for mitigating the impact of cyclones in future.

- Information sharing through mobile
- Better governmental support in rescue operations
- Better weather information

Sustainable management of fishery resources: Andhra Pradesh

1. Silver pomfrets landed at Bhairavapalem, Andra Predesh
2. *Penaeus monodon* landed at Visakhapatnam
3. *Drepane punctata* landed at Visakhapatnam
4. Monthly values of fish to debris ratio off Visakhapatnam coast
5. Andhra Pradesh policy guidance document



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dissemination mechanisms
- Mapping of cyclone prone areas in advance
- Engaging Local Self Governance (LSG) in information sharing
- Strengthen inter-governmental linkages
- Awareness campaigns for confronting cyclone

Recommendations for sustainable management and conservation of marine resources of Andhra Pradesh

A document titled "Policy Guidance on Sustaining the Marine Fisheries of Andhra Pradesh" was released in 2018. The major recommendations given in the document are -

- Review, updating and stricter implementation of AP MFRA
- Establishment of Marine Fisheries Surveillance Units
- Stock assessments of major marine resources
- Input controls

a) Regulation of fishing effort
   - Optimum Fleet Size – 1300 mechanized fishing crafts
   - Replacement of all mechanized fishing vessels older than 15 years
   - Total prohibition on construction of new mechanized boats in AP
   - Re-registration of newly replaced fishing crafts in AP
   - Classification of crafts based on engine and fishing operation
   - Engine power-craft size limitations
   - Restriction of high powered crafts from trawl fishing

b) Diversification of fishing effort
c) Mesh size regulations (40 mm square in cod end)
d) Registration of fishing gears
e) Restriction on number of ring seines
f) Seasonal closure of fishing (stricter implementation)
g) Area closures/Marine Protected Areas
h) Increasing use of economically efficient gears and fishing techniques
i) Minimization of inter-sectoral conflicts
j) Council Based Management System

Output controls
- Minimum Legal Size
- Prohibition on catch of ETP species
- Protection of vulnerable species
- Shark management program for AP

Improved MCS
- Vessel Monitoring System
- Logbook system
- Trip registration

West Bengal and Odisha

Research Project: CFD/NEC/05

The total marine fish landings of West Bengal during 2018 was 1.6 lakh t which decreased by about 56% compared to the previous year (3.6 lakh t). Analysis of catch and effort data for the period 2007-2018 revealed that the highest catch (3.65 lakh t) was in 2011 which fluctuated a lot since then. The unusual decrease in the marine fish landings in 2018 is mainly due to decrease in fishing effort which reduced by about 49 and 52% in terms of fishing units and Actual Fishing Hours (AFH) respectively compared to previous year mainly due to adverse natural calamities like low pressure and cyclones.

1

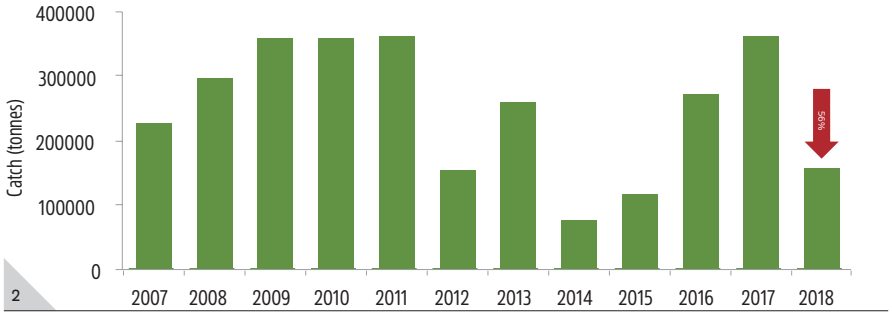
Sustainable management of fishery resources: West Bengal and Odisha

Changes in the landings of major pelagic groups in 2018 compared to 2017 in West Bengal

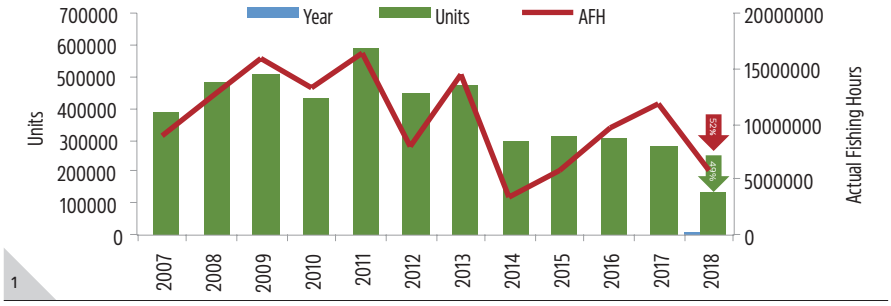
Pelagic resources	Landings (kg)		%Change
	2018	2017	
Bombayduck *Harpadon nehereus*	19260014	37951807	-49
Hilsa *Tenualosa ilisha*	13826917	57990926	-76
Golden anchovies *Coilia dussumieri*	11126953	10089726	10
Anchovies *Setipinna taty, Stolephorus waitei, Stolephorus indicus, Stolephorus commersonnii, Thryssa mystax, Thryssa dussumieri, Thryssa setirostris*	9821197	12983916	-24
Ribbonfishes *Trichiurus lepturus, Lepturacanthus savala, Eupleurogrammus muticus*	7658086	12671094	-40
Sardines *Sardinella gibbosa, Sardinella fimbriata, Sardinella longiceps, Escualosa thoracata, Dussumieria acuta*	6507104	31917507	-80
Indian mackerel *Rastrelliger kanagurta*	4503656	20258483	-78
Ilisha *Ilisha megaloptera*	3893917	14405382	-73
Horse mackerel *Megalaspis cordyla*	2387052	11744883	-80
Seer fishes *Scomberomorus guttatus, Scomberomorus commerson*	2232048	5443148	-59
Chacunda *Anodontostoma chacunda*	1577009	5333512	-70
Wolf herrings *Chirocentrus nudus, Chirocentrus dorab*	1516487	5610394	-73
Tardoore *Opisthopterus tardoore*	1416546	1142622	24
Leather-jackets *Scomberoides tol, Scomberoides tala, Scomberoides lysan, Scomberoides commersonnianus*	1345206	3126675	-57
Other carangids *Rachycentron canadum, Alepes djedaba, Atropus atropos, Alectis indica, Caranx ignobilis, Selar crumenophthalmus*	744317	447771	66
Mullets *Mugil cephalus, Chelon planiceps, Chelon parsia*	540775	901376	-40
Tunas *Auxis thazard, Euthynnus affinis, Thunnus tonggol*	180989	265457	-32
Barracudas *Sphyraena barracuda, Sphyraena obtusata*	101283	171862	-41

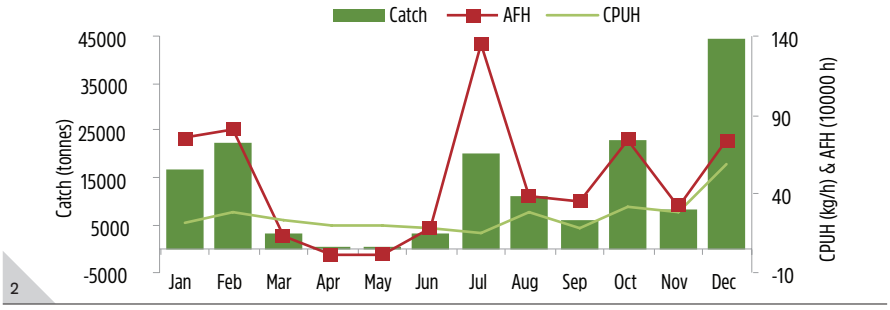
1. *Himantura undulata* landings at Digha, West Bengal

2. Marine fish catch trend of West Bengal coast during 2007-2018



Sustainable management of fishery resources: West Bengal and Odisha





1. Effort (AFH) trend of West Bengal coast during 2007-2018
2. Monthly distribution of catch, effort (AFH) and catch rate (CPUH) of West Bengal coast
3. Group wise contribution to the total marine fish landings of West Bengal coast in 2018
4. Gear-wise contribution to the total marine fish landings of West Bengal coast in 2018

Changes in the landings of major demersal groups in 2018 compared to 2017 in West Bengal

Demersal resources	Landings (kg)		%Change
	2018	2017	
Sciaenids *Johnius dussumieri, Johnius carutta, Johnius borneensis, Otolithes cuvieri, Otolithoides biauritus, Otolithes ruber, Nibea maculata, Protonibea diacanthus, Pennahia anea*	11331750	15808210	-28
Pomfret *Pampus argenteus, Pampus chinensis, Parastromateus niger*	8398287	15078024	-44
Catfishes *P. tenuispinis* (P. layardi), *Netuma thalassina, Plicofollis dussumieri, Osteogeneiosus militaris*	6457942	27354109	-76
Flatfishes *Cynoglossus macrolepidotus, Cynoglossus macrostomus, Psettodes erumei*	4730499	4382811	8
Sharks *Carcharhinus sorrah, Carcharhinus dussumieri, Carcharhinus leucas, Scoliodon laticaudus, Mustelus mosis, Rhizoprionodon oligolinx, Rhizoprionodon acutus, Chiloscyllium griseum, Alopias superciliosus*	1829915	2736007	-33
Eels *Congresox talabanoides, Congresox talabon, Muraenesox cinereus*	1738310	1123952	55
Threadfinbreams *Nemipterus randalli, Nemipterus japonicas*	1385711	2195336	-37
Rays *Himantura* spp., *Dasyatis* spp., *Mobula* spp., *Manta* spp., *Aetobatus narinari, Aetobatus flagellum*	1091469	1433669	-24
Goatfishes *Upeneus sulphureus, Upeneus vittatus*	856872	848679	1
Silverbellies *Secutor insidiator, Photopectoralis bindus, Nuchequula blochii, Eubleekeria splendens, Leiognathus equula*	740428	426982	73
Whitings *Sillago sihama, Sillaginopsis domina*	606925	2611312	-77
Threadfins *Eleutheronema tetradactylum, Leptomelanosoma indicum, Polynemus paradiseus*	591158	2820890	-79
Groupers *Epinephelus diacanthus, Epinephelus chlorostigma, Epinephelus fasciatus*	577716	128305	350
Terapon *Terapon jarbua*	487654	1363491	-64
Skates *Rhinobatos granulatus, Rhinobatos linoteus*	457216	176519	159
Lizardfishes *Saurida tumbil, Trachinocephalus myops*	254344	591704	-57

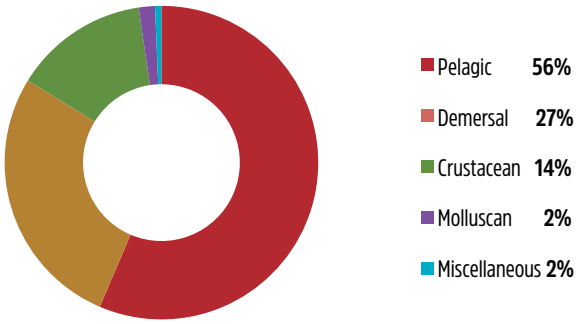
Sustainable management of fishery resources: West Bengal and Odisha

Changes in the landings of major crustacean groups in 2018 compared to 2017 in West Bengal

Crustacean resources	Landings (kg)		%Change
	2018	2017	
Penaeid shrimps	13507974	25142496	-46
Solenocera hexti, S. crassicornis	981193	1574244	-38
Metapenaeopsis stridulans	77701	60112	29
Metapenaeus monoceros, M. brevicornis and *M. affinis*	4322144	9012941	-52
Parapenaeopsis stylifera, P. sculptilis, P. hardwickii, P. uncta	4781346	7461291	-36
Penaeus indicus, P. monodon, P. semisulcaus, P. japonicus	3345590	7033908	-52
Non-penaeid shrimps	4544652	6301018	-28
Acetes indicus	2667097	2547029	5
Nematopalaemon tenuipes	21432	Not reported	0
Plesionika spp.	1856123	3753989	-51
Lobster *Panulirus homarus, P. polyphagus*	102792	309895	-67
Crabs	4062891	3789000	7
Portunus sanguinolentus, P. pelagicus	3425703	3266314	5
Charybdis feriatus, C. annulata	637002	521328	22

Changes in the landings of major molluscan groups in 2018 compared to 2017 in West Bengal

Molluscan resources	Landings (kg)		%Change
	2018	2017	
Uroteuthis spp.	284853	230926	23
Sepia spp.	2105651	4264714	-51
Sepiella spp.	107756	53733	101



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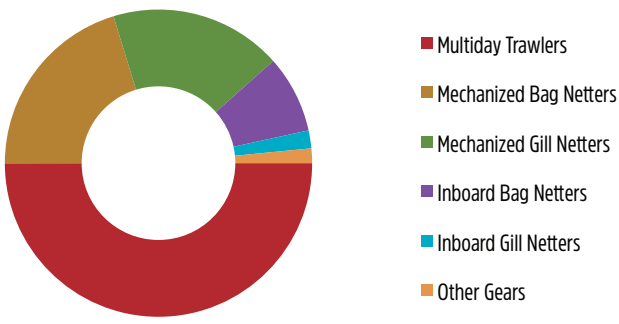

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Sustainable management of fishery resources: West Bengal and Odisha

Life history and exploitation parameters of some of the selected species of West Bengal in 2018

Species	*Lepturacanthus savala*	*Sardinella gibbosa*	*Megalaspis cordyla*	*Scomberomorus guttatus*	*Coilia dussumieri*	*Harpadon nehereus*
Catch	1733.05 T	3456.22 T	2387.05 T	1661.16 T	11028.28 T	19260.01 T
Length range`	225-775 mm	105-245 mm	125-385 mm	130-580 mm	75-165 mm	150-350 mm
Mode length	550 mm	170 mm	155 mm	280 mm	140 mm	260 mm
Lm50	375.2 mm	155 mm	257 mm	384.5 mm	141 mm	215 mm
Fecundity	15227	69205	268741	134289	76782	102277
Lc50	480.2 mm	128 mm	279 mm	203.4 mm	120.9 mm	226 mm
L∞	813.8 mm	257.25 mm	393.8 mm	593.3 mm	173.5 mm	367.5 mm
K	0.41 y-1	0.86 y-1	0.58 y-1	0.65 y-1	0.93 y-1	0.85 y-1
TMAX	7.31 y	3.48 y	5.17 y	4.61 y	3.22 y	3.52 y
M	0.63 y-1	1.32 y-1	0.89 y-1	1.00 y-1	1.43 y-1	1.31 y-1
F	1.30 y-1	4.09 y-1	1.56 y-1	1.07 y-1	2.02 y-1	2.10 y-1
Z	1.93 y-1	5.41 y-1	2.45 y-1	2.07 y-1	3.45 y-1	3.41 y-1
E	0.67	0.76	0.64	0.52	0.59	0.62
E10	0.61	0.62	0.67	0.47	0.69	0.75
E50	0.38	0.37	0.41	0.31	0.41	0.39
EMAX	0.75	0.72	0.80	0.55	0.79	0.89
Species	***Nemipterus japonicus***	***Parastromateus niger***	***Pampus argenteus***	***Cynoglossus arel***	***Plicofilis layardi***	***Penaeus monodon***
Catch	446.91 t	1296.88 t	4409.64 t	4577.52 t	4157.78 t	1214.58 t
Length range	63-297 mm	65-445 mm	70-305 mm	88-465 mm	120-445 mm	70-310 mm
Mode length	100 mm	155 mm	140 mm	240 mm	240 mm	230 mm
Lm50	145 mm	233 mm	249 mm	190 mm	330 mm	180 mm
Fecundity	47280	56809	60445	77805	237	171086-256228
LC50	96 mm	202 mm	115 mm	198 mm	168 mm	205 mm
L∞	313 mm	462 mm	315 mm	483 mm	462 mm	315 mm
K	0.54 y-1	0.58 y-1	0.62 y-1	0.42 y-1	0.42 y-1	1.6 y-1
TMAX	5.54 y	5.16 y	4.83 y	7.13 y	7.09 y	1.87 y
M	0.83 y-1	0.89 y-1	0.95 y-1	0.65 y-1	0.65 y-1	2.46 y-1
F	1.24 y-1	1.68 y-1	1.25 y-1	0.78 y-1	0.54 y-1	3.33 y-1
Z	2.07 y-1	2.57 y-1	2.20 y-1	1.43 y-1	1.19 y-1	5.79 y-1
E	0.60	0.65	0.57	0.55	0.45	0.58
E10	0.40	0.56	0.46	0.46	0.47	0.62
E50	0.31	0.34	0.32	0.30	0.32	0.39
EMAX	0.52	0.65	0.57	0.60	0.57	0.75

Sustainable management of fishery resources: West Bengal and Odisha

1. *Cynoglossus* sp. landings at Digha, West Bengal
2. *Iago omanensis* landings at Digha, West Bengal
3. *Leptomelanosoma indicum* landings at Digha, West Bengal
4. *Parastromateus niger* landings at Digha, West Bengal




Species	*Solenocera crassicornis*	*Penaeus semisulcatus*	*Parapenaeopsis stylifera*	*Parapenaeopsis sculptilis*
Catch	981.20 T	830.78 T	1625.35 T	1097.65 T
Length range	45-125 mm	101-242 mm	55-130 mm	63-180 mm
Mode length	100 mm	180 mm	100 mm	145 mm
Lm50	80 mm	145 mm	75 mm	100 mm
Fecundity	4000-85876	283813-668076	50737-429000	51,907-306400
Lc50	90 mm	161 mm	98 mm	129 mm
L_∞	129 mm	262.5 mm	133.8 mm	183.8 mm
K	1.7 y-1	1.6 y-1	1.7 y-1	1.7 y-1
TMAX	1.76 y	1.87 y	1.76 y	1.76 y
M	2.61 y-1	2.46 y-1	2.61 y-1	2.61 y-1
F	2.87 y-1	2.62 y-1	5.99 y-1	3.11 y-1
Z	5.48 y-1	5.08 y-1	8.60 y-1	5.72 y-1
E	0.52	0.52	0.70	0.54
E10	0.66	0.66	0.70	0.67
E50	0.41	0.39	0.42	0.40
EMAX	0.80	0.80	0.80	0.80

Sustainable management of fishery resources: West Bengal and Odisha

Changes in the landings of major pelagic groups in 2018 compared to 2017 in Odisha

Pelagic resources	Landings (t)		% change
	2018	2017	
Lesser sardine *Sardinella fimbiata*, *Sadinella* spp.	16253.5	13260.6	22.6
Indian mackerel *Rastrelliger kanagurta*	12364.5	7602.9	62.6
Ribbonfishes *Trichiurus lepturus, T. ganegeticus, Lepturacanthus savala, Eupleurogrammus muticus*	5929.2	10501.9	-43.5
Hilsa shad *Tenualosa ilisha*	3889.6	4529.3	-14.1
Other anchovies *Stolephorus indicus, S. commersonnii, Thryssa mystax, T. setirostris, T. malabarica, T. hamiltoni, T. kammalensis, T. kammalensoides, T. dussumieri, Setipinna phasa, S. tenuifilis*	3486.4	6689.705	-47.9
Bombayduck *Harpadon nehereus*	3136.9	2387.7	31.4
Ilisha *Ilisha megaloptera, I. elongate, I. melastoma, Ilisha* spp.	2615.4	3944.6	-33.7
Coilia *Coilia dussumieri, C. ramcarati*	2330.2	3946.2	-41.0
Seerfish *Scomberomorus guttatus, S. commerson*	1840.7	2024.4	-9.1
Other carangids *Alectis indica, A. ciliaris, Alepes djedaba, A. kleinii, A. melanoptera,Atropus atropos, Atule mate, Trachinotus spp., Selar crumenophthalmus, Caranx sexfasciatus, C. ignobiolis, Carangoides talamparoides*	1567.7	2738.9	-42.8
White sardine *Escualosa thoracata*	1545.8	1166.4	32.5
Horse mackerel *Megalaspis cordyla*	1209.0	4076.4	-70.3
Mullet *Mugil cephalus, Chelon parsia, Valamugil* spp.	1136.1	1011.6	12.3
Wolf-herring *Chirocentrus dorab, C. nudus*	454.3	754.0	-39.7
Leather-jacket *Scomberoides commersonnianus, S. tol*	372.2	1248.7	-70.2
Tardoore *Opisthopterus tardoore*	296.0	1091.1	-72.9
Halfbeak and fullbeak *Ablennes hians, Strongylura strongylura, S. leiura, Tylosurus crocodilus, Hemiramphus archipelagicus, Hyporhamphus limbatus, Rhynchorhamphus* spp.	259.9	254.4	2.2
Indian oil sardine *Sardinella longiceps*	228.9	226.5	1.1
Rainbow sardine *Dussumieria acuta*	214.8	57.7	272.3
Other shad *Hilsa kelee*	185.8	738.5	-74.8
Scad *Decapterus russelli, Decapterus* spp.	142.6	24.3	486.8
Barracuda *Sphyraena putnamae, S. jello, S. obtusata*	117.0	316.24	-63.0
Tuna *Euthynnus affinis*	74.0	310.9	-76.2
Gizzard shad *Anodontostoma chacunda*	68.1	599.6	-88.6
Cobia *Rachycentron canadum*	53.0	54.8	-3.3
Billfish *Istiophorus platypterus*	17.9	5.0	258.0
Dolphinfish *Coryphaena hippurus*	7.5	2.0	275.0

Sustainable management of fishery resources: West Bengal and Odisha

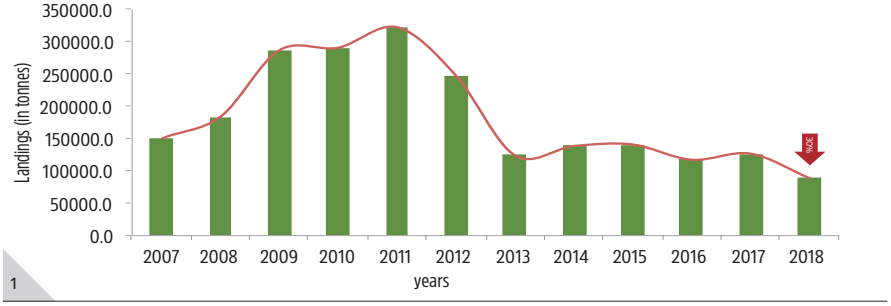
The monthly catch trend showed the last quarter (October, November and December) as the maximum productive period of the year with maximum catch and catch rate (CPUH) being observed in December. Higher catch and catch rate (CPUH) was also observed during January and February which gradually decreased towards March before the onset of fishing ban during middle of April to June. The catch though decreased during the fishing ban, the catch rate (CPUH) from the traditional fishing crafts and gears (20 kg/h) maintained itself near the average catch rate of the year (26 kg/h). Maximum contribution to the marine fish landings was observed from pelagic resources (90,000 t) followed by demersal (44,000 t), crustacean (22,000 t) and molluscan resources (2.7 thousand t).

Pelagic resources: With an annual landing of about 90,000 t, the pelagic fishery resources contributed nearly 56% to the total marine fish landings. Major resources were Bombayduck (19260 t), hilsa (13827 t), golden anchovies

Changes in the landings of major demersal groups in 2018 compared to 2017 in Odisha

Demersal resources	Landings (t)		% change
	2018	2017	
Croaker *Johnius carutta, Johnius spp.,Kathala axillaris, Otolithoides biauritus, Otolithes ruber, Nibea maculate, Protonibea diacanthus, Pennahia anea, Panna microdon, Daysciaena albid, Chrysochir aureus, Pterotolithus maculatus*	8292.7	14112.7	-41.2
Pomfret *Pampus argenteus, P. chinensis, Parastromateus niger*	2912.8	6056.1	-51.9
Catfish *Plicofollis dussumieri, P. tenuispinis (P. layardi), Netuma thalassina, N. bilineata, Osteogeneiosus militaris, Plotosus canius*	2859.7	4484.9	-36.2
Soles *Cynoglossus arel, C. lingua, C. dubius, C. macrostomus, Cynoglossus* spp.	1484.1	1586.3	-6.4
Eel *Muraenesox bagio, congresox talabonoides, Strophidon sathete*	560.7	1457.9	-61.5
Sillago *Sillago sihama, S. vincenti, Sillago* spp., *Sillaginopsis panijus*	486.5	348.7	39.5
Goatfish *Upeneus sulphurous, U. supravittatus*	437.2	809.2	-46.0
Threadfin *Eleutheronema tetradactylum, Leptomelanosoma indicum, Polynemus paradiseus, Polydactylus sextarius*	379.6	404.3	-6.1
Pufferfish *Lagocephalus inermis, L. lunaris, L. spadiceus, Takifugu oblongus*	372.3	399.7	-6.9
Silverbellies *Eubleekeria splendens, Gazza achlamys, Karalla daura, K. dussumieri, Leiognathus equulus, L. brevirostris, Photopectoralis bindus, Secutor insidiator, S. ruconius*	334.6	1210.7	-72.4
Tigerperch *Terapon jarbua, T. theraps*	257.3	706.5	-63.6
Seabream *Rhabdosargus sarba, Acanthopagrus berda*	210.8	142.0	48.5
Grunts *Pomadasys kaakan, P. maculatus*	187.4	99.8	87.8
Threadfinbream *Nemipterus japonicus, N. randalli, N. bipunctatus*	186.9	1678.4	-88.9
Driftfish *Ariomma indicum*	173.6	148.8	16.7
Shark *Carcharhinus sorrah, C. amblyrhynchos, C. leucas, Chiloscyllium indicum, Rhizoprionodon oligolinx, Scoliodon laticaudus, Sphyrna lewini*	165.6	1045.0	-84.2
Grouper/Rockcod *Epinephelus coioides, E. latifasciatus, E. epistictus*	158.6	95.8	65.6
Ray *Gymnura poecilura, pateobatis bleekeri, P. gerradi, Himantura uarnak, pastinachus sephen, Rhinoptera javanica, Brevitrygon imbricate, Aetobatus* spp.	141.7	601.2	-76.4
Lizadfish *Saurida micropectralis, S. undosquamis*	124.7	160.1	-22.1
Snapper *Lutjanus johnii, L. argentimaculatus, L. rivulatus, Lutjanus* spp.	89.9	576.0	-84.4
Flatheads *Platycephalus indicus, Platycephalus* spp., *Grammoplites scaber*	67.9	215.3	-68.5
Barramundi *Lates calcarifer*	59.5	9.2	546.7
Priacanthus *Priacanthus hamrur*	49.9	240.7	-79.3

Sustainable management of fishery resources: West Bengal and Odisha



Gear-wise contribution to the total marine fish landings of Odisha coast in 2018

Gear	MDTN	MGN	NM	OBGN	OBHL	OTHRS	Total
Catch (t)	37426.0	2136.5	2810.6	41025.8	2167.0	3611.7	89177.5
% contribution	42.0	2.4	3.2	46.0	2.4	4.0	100

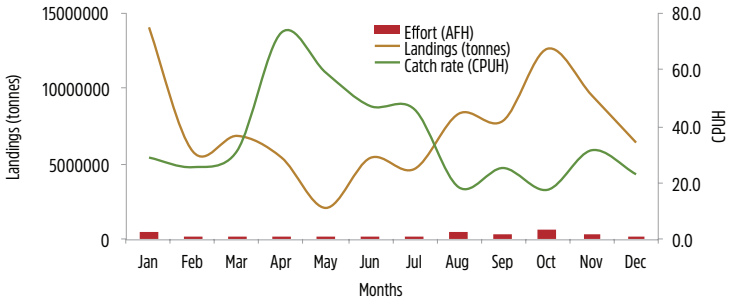
MDTN: mechanized multiday trawlers; MGN: mechanized gillnetters; NM: non-mechanized gears, OBGN: motorized gillnet; OBHL: motorized hook & line, OTHRS: other type of fishing gears

Length range, mean length and sex ratio of important resources of Odisha studied during the year 2018

Species	Sample size (n)	Length range (cm)	Mean length (cm)	Sex ratio (M:F)	Maturity (%)
Sillago vincenti	195	10.7-35.0	22.8	0.61	65
Sillago sihama	208	3.7-23.4	16.2	1.01	77
Iago omanensis	149	13.3-68.2	38.2	0.13	85
Scoliodon laticaudus	103	22.2-51.5	34.2	0.66	20
Gymnura poecilura	71	22.1-73.1	38.9	0.92	32
Otolithes ruber	109	15.7-49.0	26.9	0.89	37
Plicofollis tenuispinis (P. layardii)	86	22.2-49.5	33.8	0.58	27
Plicofollis dussumieri	59	24.9-59.1	42.1	0.78	5
Rhabdosargus sarba	109	9.0-49.6	20.7	1.25	58
Trichiurus lepturus	154	16.9-42.0	24.2	0.88	45
Megalaspis cordyla	169	14.8-42	26.3	0.93	31.4
Ilisha megaloptera	143	12.0-33.5	22.8	0.33	19
Sepiella inermis	482	2.9-7.8	5.56	0.92	43.3
Sepia pharaonis	176	8.1-30.0	18.7	1.02	46.0
Uroteuthes (P.) duvaucelli	944	3.3-20.6	9.0	1.30	41.2
Sepia aculeata	151	4.6-19.7	13.0	0.72	49.0
Portunus sanguinolentus	332	4.5-16.8	11.9	0.90	74.0
Portunus pelagicus	186	4.7-18.7	13.7	1.04	73.5
Charybdis feriata	88	5.5-13.2	9.7	0.91	77.9
Parapenaeopsis stylifera	301	6.7-12.9	9.9	0.47	55.2
Metapenaeus monoceros	121	8.9-19.2	13.1	0.41	34.2
Solenocera crassicornis	460	6.0-12.7	9.02	0.49	61.0
Metapenaeus affinis	229	7.8-20.3	13.0	1.06	70.0

Sustainable management of fishery resources: West Bengal and Odisha

1. Marine fish catch trend of Odisha coast during 2007-2018
2. Monthly distribution of catch, effort (AFH) and catch rate (CPUH) of Odisha coast
3. Resource group-wise contribution to the total marine fish landings of Odisha coast in 2018
4. Changes in the landings of major crustaceans in 2018 compared to the landings in 2017 in Odisha
5. Changes in the landings of major cephalopods in 2018 compared to the landings in 2017 in Odisha



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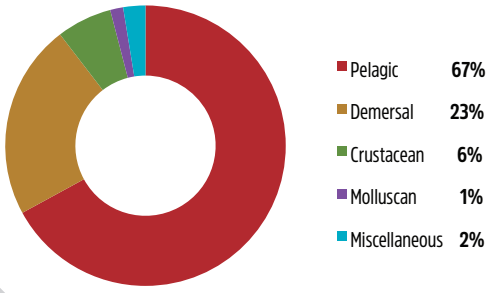

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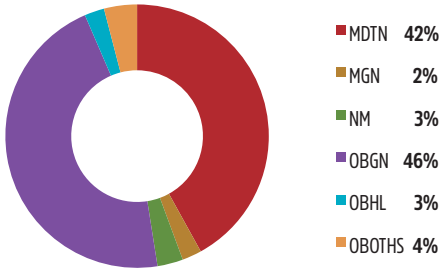

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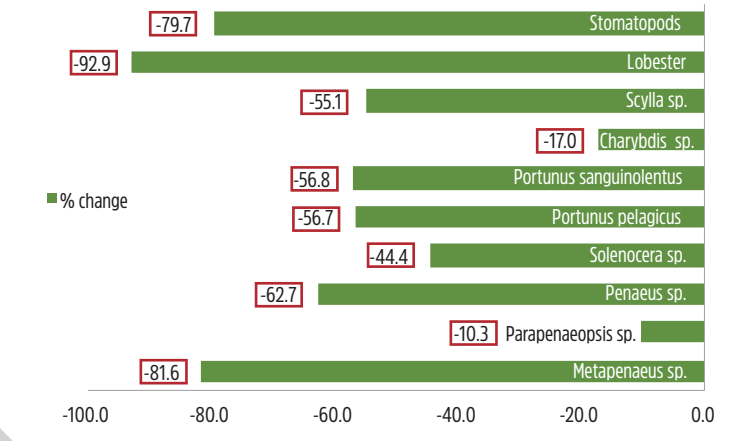

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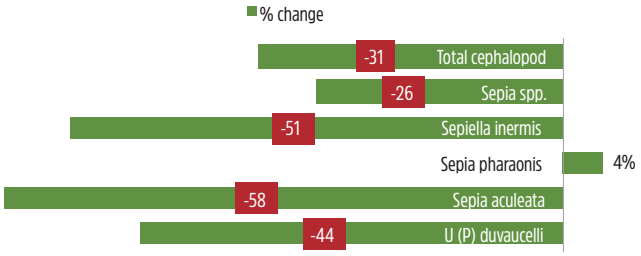
Sustainable management of fishery resources: West Bengal and Odisha



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(11127 t), anchovies (9821 t), ribbonfishes (7658 t), sardines (6507 t), Indian mackerel (4503 t), ilisha (3893 t), horse mackerel (2387 t), seerfishes (2232 t), chacunda (1577 t), wolf herrings (1517 t), tardoores (1417 t), leatherjackets (1345 t) and other carangids (744 t). Catch of most of the resources decreased tremendously except for golden anchovies, tardoore and other carangids.

Demersal resources: Demersal fishery resources contributed nearly 27% (44,000 t) to the total marine fish landings. Major resources were sciaenids (11332 t), pomfrets (8398 t), catfishes (6458 t), flatfishes (4730 t), sharks (1830 t), eels (1738 t), threadfinbreams (1386 t), rays (1091 t), goatfishes (857 t), silverbellies (740 t), whitings (607 t), threadfins (591 t), groupers (578 t), terapons (488 t), skates (457 t) and lizardfishes (254 t). Catch of most of the resources decreased except for flatfishes, eels, silverbellies, groupers and skates. Among these groupers and skates showed tremendous increase of 350 and 159% respectively compared to previous year.

Crustacean resources: With an annual landing of about 22,000 t, crustacean fishery resources contributed nearly 14% to the total marine fish landings. Major resources were penaeid shrimps (13508 t), followed by non-penaeid

Sustainable management of fishery resources: West Bengal and Odisha

shrimps (4545 t), crabs (4063 t) and lobsters (103 t). Penaeid shrimps were represented by *Parapenaeopsis* spp. such as *P. stylifera, P. sculptilis, P. hardwickii* and *P. uncta* contributing 4781 t followed by *Metapenaeus* spp. like *M. monoceros, M. brevicornis* and *M. affinis* forming 4322 t; *Penaeus* spp. like *P. indicus, P. monodon, P. semisulcatus, P. japonicus* contributing 3346 t; *Solenocera* spp.–*S. hexti, S. crassicornis* contributing 981 t and *Metapenaeopsis stridulans* contributing 78 t. Non-penaeid shrimps were represented by *Acetes indicus* forming 2667 t followed by *Plesionika* sp. (1856 t). Crabs were mainly *Portunus sanguinolentus* and *P. pelagicus* together contributing 3426 t followed by *Charybdis feriatus* (221 t). *Panulirus homarus* (64 t) and *P. polyphagus* (1 t) formed the lobster landings. Most of the crustacean resources showed decreasing trend in their landings except for *Metapenaeopsis stridulans, Acetes indicus* and crabs.

Molluscan resources: Molluscan fishery resources contributed nearly 2% (2.7 thousand t) of the total marine fish landings of West Bengal. The major resources under this group were *Uroteuthis (Photololigo) duvaucelii, Sepia aculeata, Sepia pharaonis* and *Sepiella inermis*. The landings decreased by about 41% compared to the previous year.

Gearwise contribution: Maximum landings was from mechanized multiday trawlers (50%) followed by mechanized bagnetters (20%), mechanized gillnetters (18%) and in-board bagnetters (8%). Minor contribution was also made by in-board gillnetters (2%) and other type of fishing gears (2%).

Biology: Growth parameters (L∞, K and t0), mortality and exploitation parameters (M, F, Z and E) and reproductive biology parameters (fecundity, age/length at maturity and food and feeding habits) were estimated for selected commercially important marine species of the state.

1. Gear-wise contribution to the total marine fish landings of Odisha coast in 2018
2. Shrimps landed at Digha Mohana fish landing centre, West Bengal
3. Shrimps landed at Digha Mohana fish landing centre, West Bengal


2

Odisha

The total marine landings of Odisha coast during 2018 was estimated at 89177.5 t registering a decline of about 30% compared to the previous year (126958.2 t). Analysis of twelve year landings from 2007 to 2018 revealed the highest catch of 322683.8 t in 2011 followed by gradual decline and lowest during the current year. This may be due to the reduction in fishing days due to natural calamities like low pressure/ cyclonic events. Monthly catch analysis of 2018 indicated that the fishery attained peak during the first quarter of the year registering highest catch in January, after which the catch declined gradually with the lowest catch in May due to the monsoon fishing ban period. The fishery again revived during the last quarter of the year i.e. post ban period which is a general characteristic for Indian marine fisheries. However, lowest catch rate (CPUH) was observed during first and last quarter of the year and highest in monsoon fishing ban period i.e. April and May. Though the catch decreased during the ban period, catch rate (CPUH) from the traditional fishing crafts and gears maximized during the period. Group wise analysis in 2018 indicated highest catch by pelagic (59797.2 t) followed by demersal (20083.5 t), crustacean (5683.2 t), molluscan (1334.6 t) and miscellaneous (2279.0 t) fishery resources.

Pelagic resources: The annual landings of pelagic fishery resources were estimated at 59797.2 t (67%) during 2018. Major resources were lesser sardine (16253.5 t), Indian mackerel (12364.5 t), ribbonfish (5929.2 t), hilsa shad (3889.6 t), anchovies (3486.4 t), Bombayduck (3136.9 t), ilisha (2615.4 t), coilia (2330.2 t), seerfish (1840.7 t), other carangids (1567.7 t), white sardine (1545.8 t), horse-mackerel (1209.0 t), mullet (1136.1 t), wolf-herring (454.3 t), leatherjacket (372.2 t), tardoore (296.0 t), halfbeak and fullbeak (259.9 t), Indian oil sardine (228.9 t), rainbow sardine (214.8 t) and other shad (185.8 t). Catch of lesser sardine, Indian mackerel, Bombayduck, white sardine, mullet, halfbeak and fullbeak, Indian oil sardine, rainbow sardine, scad, billfish and dolphinfish increased whereas ribbonfish, hilsa shad, anchovies, ilisha, coilia, seerfish, other carangids, horse mackerel, wolf-herring, leatherjacket, other shad, barracuda, tuna, gizzard shad, cobia declined in 2018 in comparison with the previous year.

Demersal resources: The annual landings of demersal fishery resources were estimated at 20083.5 t (23%) of the total marine fish landings. Major resources were croaker (8292.7 t), pomfret (2912.8 t), catfish (2859.7 t), soles (1484.1 t), eel (560.7 t), sillago (486.5 t), goatfish (437.2 t), threadfin (379.6 t), pufferfish (372.3 t), silverbellies (334.6 t), tigerperch (257.3 t), seabream (210.8 t), grunts (187.4 t), threadfinbream (186.9 t), driftfish (173.6 t), shark (165.6 t), grouper/ rockcod (158.6 t), ray (141.7 t), lizardfish (124.7 t), snapper (89.9 t) and flatheads (67.9 t). Most of the demersal resources showed tremendous decrease in their catch except for sillago, seabream, grunts, driftfish, grouper/rockcod and ray in 2018 in comparison to 2017.

Crustacean resources: Crustacean fishery resources contributed nearly 6% (5.6 thousand t) to the total marine fish landings. Major resources were penaeid


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Sustainable management of fishery resources: West Bengal and Odisha

1. *Rhabdosargus sarba* landings at Chandrabhaga Fish Landing Centre, Puri, Odisha
2. *Tenualosa ilisha* landings at Bahabalpur Fish Landing Centre, Balasore, Odisha
3. *Tenualosa ilisha* landings at Bahabalpur Fish Landing Centre, Balasore, Odisha
4. Cephalopod landings at Paradeep Fishing Harbour, Jagatsinghpur, Odisha
5. *Shrimp landings at Paradeep Fishing Harbour, Jagatsinghpur, Odisha*

shrimps (3861.9 t), followed by crabs (1818.2 t), lobsters (2.6 t) and stomatopods (0.5 t). Penaeid shrimps were represented by *Parapenaeopsis* spp. such as *P. stylifera, P. sculptilis, P. hardwickii, P. uncta, P. maxillipido* forming 2152 t followed by genus *Metapenaeus–M. monoceros, M. brevicornis* and *M. dobsonii* contributing 790 t; *Penaeus* group such as *P. indicus, P. monodon, P. semisulcatus, P. japonicus, P. merguensis* contributing 299 t; *Solenocera–S. hexti, S. crassicornis*–621 t. Crabs were constituted by *P. sanguinolentus* (965 t) and *P. pelagicus* contributing 304.4 t followed by *Charybdis sp.* which contributed about 519.7 t. Lobster landings were by *P. polyphagus* (2.3 t) with negligible contribution by *P. homarus* (0.1 t). Catch trend of all crustacean resources decreased compared to last year. Mechanized sector contributed highest (93%) followed by motorized (6%) and non-motorized of (1%) to the total landings of crustaceans in the current year and the highest landings was in October.

Molluscan resources: The annual landings of molluscan resources were 1.3 thousand t, forming 2% of the total marine fish landings. The major resources were *S. aculeata* (387.5 t), followed by *U. (P.) duvaucelii* (375.3 t) followed by *S. elliptica* (339.7 t), *S. pharaonis* (102.7 t), *S. inermis* (77.8 t) and other *Sepia* sp. (51.5 t). Cephalopod landings decreased by 31% compared to the previous year and lowest catch recorded since last ten years. Most of the cephalopod species revealed decreasing catch trend except for *S. pharaonis* where a minimal 4% increase in landings was observed from last year. In case of squids the total landings were by the single species *U. (P.) duvaucelii* with 44% decrease from last year. Multiday trawl was the single highest contributor to the cephalopod landings compared to other gears in 2018. January recorded highest landing of both squid and cuttlefish.

Gearwise contribution: Maximum catch was contributed by motorized gillnet (46%) and mechanized multiday trawlers (42%). A minor contribution was also made by non-mechanized gears (3.2%), mechanized gillnetters (2.4%) and motorized hook & line (2.4%).

Large Pelagics

Research Project: PEL/LPR/04

Large pelagics in the fishery are represented by fast moving finfishes, which enjoy wider distribution in shelf and oceanic waters. The major groups which supported fishery along the Indian waters are 'tunas, spanish mackerels (seerfish), barracudas, billfishes, mahi mahi, queenfishes, rainbow runner, kingfish and needlefishes' in the order of relative abundance. The general increasing trend which was observed in their landings over the years continued during the year also. Their landing during 2018 was 249,876 t by registering an improvement of about 22% over the previous years landing. They

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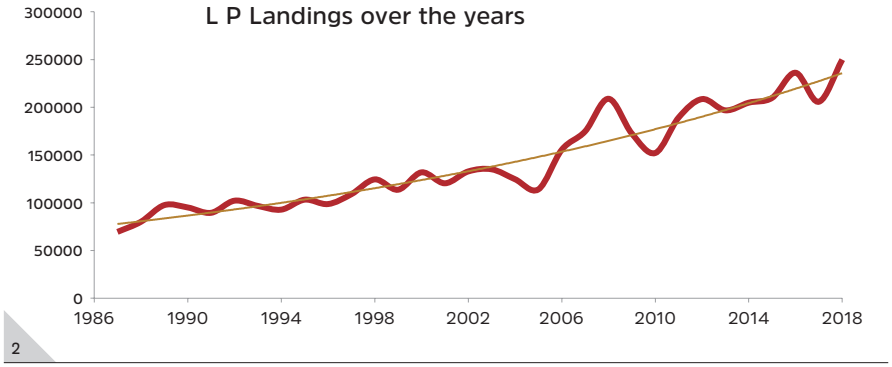
Sustainable management of fishery resources: Large Pelagics

1. *Large pelagics landed at Kochi fisheries harbour by oceanic fishing vessels*
2. *Landing trend of large pelagics along the Indian coast*
3. *Catch composition of large pelagics in 2018*



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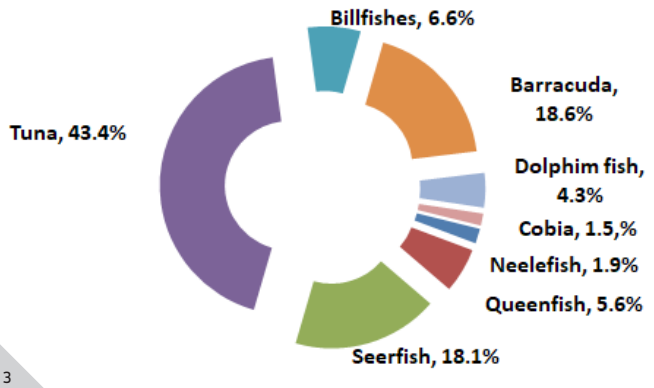
Landings (t) of different large pelagic groups along the mainland coast during 2018

Species/State	AP	DD	Goa	Guj	Kar	Ker	MR	Od	Pud	TN	WB	Total	Group (%)
Barracuda	2806	840	136	3096	8941	4407	1026	117	1242	23658	101	46370	18.6
Billfishe	1803	134	0	1063	107	5856	356	18	21	6957	68	16382	6.6
Cobia	43	325	0	1529	389	487	124	53	38	633	138	3758	1.5
Mahi mahi	367	894	252	3722	370	2409	678	7	39	2024	0	10763	4.3
Needlefish	368	0	111	811	795	533	339	173	4	1480	1	4615	1.8
Queenfish	984	645	222	4382	2395	278	1909	372	35	1379	1345	13947	5.6
Rainbow runner	0	0	0	0	21	139	178	0	21	426	0	784	0.3
Seerfishe	3793	2203	563	10494	4520	4228	6964	1841	1054	7294	2232	45185	18.1
Tuna	6730	6048	5273	14533	12480	22170	5869	74	80	34634	181	108072	43.3
Total	16895	11090	6558	39632	30016	40506	17442	2656	2533	78483	4066	249876	-
State (%)	6.8	4.4	2.6	15.9	12.0	16.2	7.0	1.1	1.0	31.4	1.6	-	-



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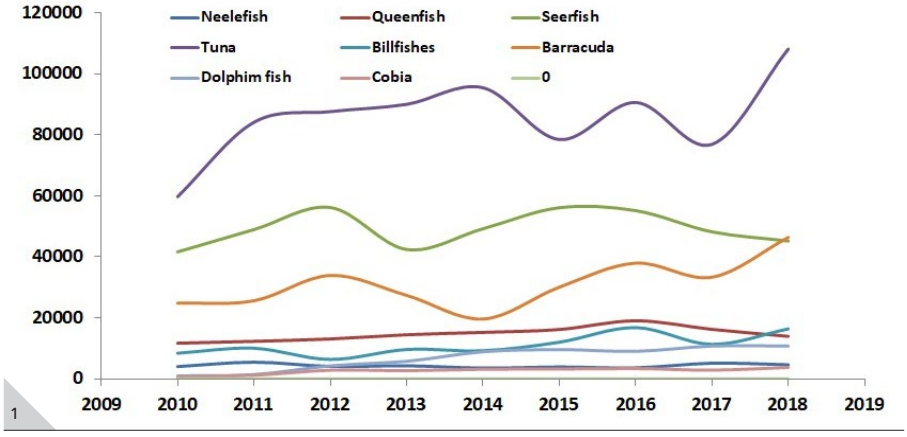
constituted nearly 7.2% to the national total marine fish landing.

Major share of the landing was constituted by tunas, followed by barracudas, seerfishes and billfishes. Among the maritime states Tamil Nadu is the major contributor, followed by Kerala, Gujarat and Karnataka.

Among the major resources tuna, barracuda and billfish are showed an increasing trend in 2018. Whereas landings of seerfishes declined marginally and others maintaining a steady level of landing over the years

Sustainable management of fishery resources: Large Pelagics



1. Resource composition of large pelagics in the landing in 2018
2. Deep bodied queenfish, *Scomberoides* sp.nov.

Landing trend of component resources of large pelagics

Resources	Hooks &lines	Gillnets	Trawl	Purse-seine	Ring-seine	Other gears
Barracuda	2.1	9.0	78.2	2.7	0.5	7.5
Billfish	14.2	41.4	8.0	0.4	0.0	35.9
Cobia	9.3	37.2	45.8	0.5	0.0	7.2
Mah mahi	9.9	32.3	27.1	7.6	0.4	22.7
Needlefish	14.2	41.5	27.7	13.2	0.0	3.3
Queenfish	4.4	22.0	48.5	23.4	0.5	1.3
Rainbow runner	3.0	50.6	38.2	2.9	0.8	4.4
Seerfish	9.1	42.1	31.7	10.4	0.2	6.5
Tuna	6.3	49.4	6.3	20.3	3.6	14.1
Total LP	6.8	38.1	28.2	12.7	1.7	12.4

The major gear landing large pelagics along the coast is gillnets followed by trawl and purse-seine (Table 2). Contribution by hooks and line was very nominal. This indicates that fishes frequenting in the upper water column are the main target, which comprises mainly of young ones or smaller size groups.

Fishery of large pelagics were supported by 42 species during 2018. Species exhibit temporal and spatial variations in distribution and abundance.

Biology and population parameters: Biological observations indicated

Species in landing (42)

Tunas	8
Seerfishes	- 4
Billfishes	- 6
(4 marlins, one each sailfish and swordfish)	
Barracudas	- 9
Queenfishs	- 5
rainbow runner	1
Needlefishes	6
Mahimahi	2
Cobia	1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that mainly adults constituted the landings of most species. Young ones of most species are observed mainly in the landings by gillnets and trawls. Immature fishes in the landings were estimated based on the Minimum Legal Size (MLS). The juvenule percentage was more in *S. commerson* (44.7%), *R. canadum* (60.2%) and several barracuda species. This indicates that, hooks and lines are most ideal for LP fishing.

Most species showed prolonged spawning activity with almost round the year spawning along the Indian coast. However, most have very specific spawning periods during which time massive spawning occurs.

Size range of major species and composition of immature fishes in the landing

Species	Size range in the landing	MLS	Young ones %	
			Gillnet	Hooks & line/Trawl*
Thunnus albacares	35-170	50.0	1.9	0.4
Thunnus tonggol	29-94	44.0	7.0	0
Katsuwonus pelamis	25-75	35.0	0.85	0
Euthynnus affinis	16-96	31.0	0.7	0.4
Sarda orientalis	32-78	35.0	1.4	0
Auxis rochei	18-38	18.0	3.6	1.9
Auxis thazard	20-68	25.0	1.2	0
Gymnosarda unicolor	36-104	50.0	0	0.8
Scomberomorous commerson	12-130	50.0	31	16*
Scombermorous guttatus	22-64	37.0	12	6*
Scomberoides tala	26-62	30.0 FL	0	1.3
Scomberoides tol	13-58	22.5 ,,	1.1	0.9
Scomberoides commersonnianus	18-126	31.5 ,,	2	1.1
Sphyraena jello	34-126	30.0 TL	3.6	2.4 *
Sphyraena putnamae	24-58	27.0 ,,	3	0.3
Sphyraena obtusata	14-34	17.5 ,,	0	1.8*
Sphyraena barracuda	56-118	76.0 ,,	4.7	0
Rachycentron canadum	16-156	61.0 ,,	1.1	15.9*
Coryphaena hippurus	28-136	38.0 ,,	2.2	2.7*

Sustainable management of fishery resources: Large Pelagics

Peak period of spawning in major LP species

Species	Peak spawning periods
R.canadum	September-November, May
S.commerson	May,Aug & October-November
S. guttatus	September-November
E. affinis	January-February & October-November
A. thazard	July-September
A. rochei	May-October
S. obtusata	May & September-November
S. putnamae	January-February & October-December
S. commersonnianus	September – October
S. tol	March-May & November-December
S. tala	March & September-October
S.lysan	September-October

Taxonomy: A new species of queenfish was described from southern coast of India. In addition to conventional morphometry, otolith morphometry through shape analysis and genetic tools were employed in the study. The new species, *Scomberoides* sp.nov. was named as "*deep bodied queenfish*" owing to the broader nature of its body.

Stock status: Detailed stock assessment shows that the *narrow-barred Spanish mackerel*(*Scomberomorus commerson*) and Kawa kawa (*Euthynnus. Affinis)* were subjected to marginal overfishing. Yellowfin tuna (*Thunnus albacares)* and Mahi mahi *(Coryphaena hippurus)* are fished below the optimum level indicating bright scope for enhanced production of these species.

Rapid stock assessment of all major resources shows that stock of most species are in healthy state with stock at abundant level. The stock of both Spanish mackerels (*Scomberomorus commerson* and S. *guttatus*) and talang queenfish (*Scomberodes commersonnianus*) were at less abundant level.

The situation suggests considerable scope for increasing yield of most species from the present grounds. There is also scope for enhancing production by extending fishing operations to other less exploited areas like Andaman and Lakshadweep seas.

Ageing using hard parts: Growth parameters of mahi mahi and yellowfin

Biological reference points and status of exploitation of LP species in 2018

Species	F/F_{MSY}	B/B_{MSY}	SSB-%	Status of exploitation
E. affinis	1.071	0.984	36	Subjected to overfishing (marginal)
T. albacares	0.867	1.22	48	Not subjected to overfishing
S. commerson	1.170	0.863	29	Subjected to overfishing
C. hippurus	0.842	1.28	53	Not subjected to overfishing

Sustainable management of fishery resources: Large Pelagics

1. Cobia landed at Kochi
2. Mahi mahi landed by long liners at Kochi
3. Jewellery designed from fish otoliths

tuna were revised using age length data developed from sagittal otolith studies. It showed that both species are growing comparatively faster compared to the estimates obtained from length frequency based analysis.

Otoliths of some species are very lustrous and possess beautiful shape and appearance and thus offer considerable potential for their use in gem industry like pearls. If popularized, it has scope to offer employment for fisher youth of coastal areas.

Bivalve Fisheries and Management

Research Project No:MFD/BIV/15

Fishery Management Plans (FMPs) and recruitment dynamics of bivalves

Bivalve production in 2018 was estimated at 1,32,531 tonnes. The fishery was dominated by clams, consisting of 76.3%, followed by mussels, 15.3% and oysters, 8.4%. The major bivalve landing centres in Kerala (KE), Karnataka (KA), Goa (GA), Maharashtra (MH), Tamil Nadu (TN), Andhra Pradesh (AP) and Odisha (OD) were monitored.

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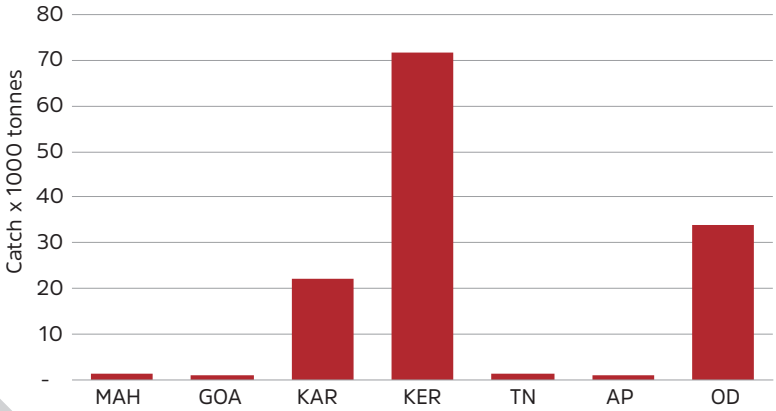
Sustainable management of fishery resources: Bivalve Fisheries and Management



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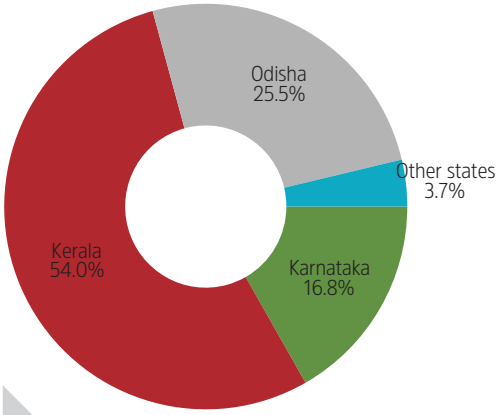

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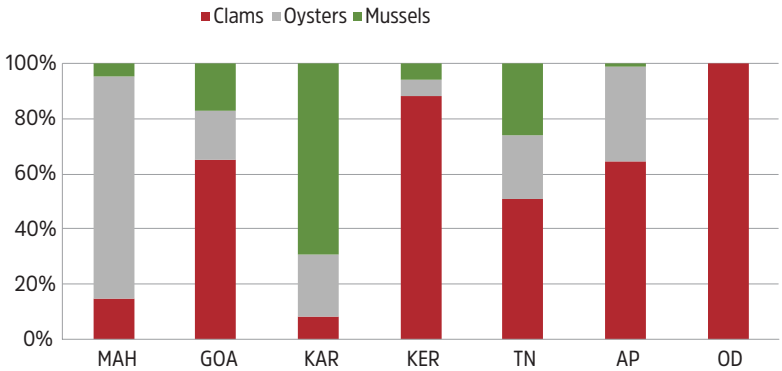

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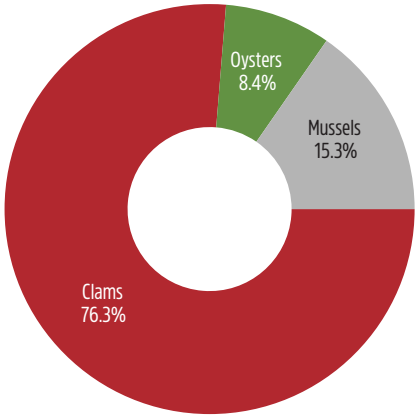

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1. Clam fisher in Udyavara Estuary, Karnataka
2. Estimated bivalve fishery production in India by State
3. Contribution of clams, oysters and mussels by State
4. Bivalve proportion in India by State
5. Contribution of clams, oysters and mussels to all India bivalve production

Kerala (54%), Odisha (25.5%) and Karnataka (16.8%) were the important bivalve producing States followed by Tamil Nadu (1.1%), Maharashtra (1%) Goa (0.8%) and Andhra Pradesh (0.8%).

Clams dominated the fishery contributing 76.3% to the annual bivalve production followed by mussels, 15.3% and oysters, 8.4%.

Maharashtra: Estimated bivalve landing of Maharashtra was 1,318 t. Oysters dominated the fishery (80%) followed by clams (15%) and mussel (5%). Fishery was observed mainly in Sindhudurg and Ratnagiri Districts. Clam landing comprised of *Meretrix meretrix* (47%), *M. casta* (22%), *Paphia malabarica* (21%), *Marcia opima* (7%) and other clams (2%). *Perna viridis* were commercially exploited off Ratnagiri. *Saccostrea cucullata* contributed 90% to the oyster catch. Inter-state transportation of *P. malabarica* from Kerala to Ratnagiri and Mumbai markets of Maharashtra continued

Sustainable management of fishery resources: Bivalve Fisheries and Management

1. Oyster collection at Jakimirya, Ratnagiri
2. Mussel fishery in Gangolli, Karnataka
3. Handpicking of clams at Devgad, Sindhudurg
4. Oysters fishery in Gangavali Estuary, Karnataka
5. Clam fishery in Udyavara Estuary, Karnataka
6. Fisherman collecting bivalves in Kakinada Bay
7. *Perna indica* fishery in Kanyakumari District
8. Oyster picking in Buckingham Canal, Chennai


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during the period. Condition index of *P. malabarica* ranged from 13.72 to 57.51, with highest in October.

Goa: Bivalve fishery estimated at 1,104 t, was observed in Pernem, Terekhol-Keri Canacona, Sal and Mandovi-Zuari Estuaries. Clams dominated the fishery. Inter-state transportation of bivalves from Kerala and Karnataka to Goa continued in 2018.

Karnataka: Among bivalves, *P. viridis* dominated the fishery in Karnataka contributing 69.3% to the production (22,209 t). During pre-monsoon period, mussel fishery was observed near bar mouths and estuaries along Karnataka. Onset of mussel spat settlement off Karnataka was observed from September 2018 when 3.5mm *P. viridis* was collected from intertidal beds. Spat fall continued in October (4.3mm), November (5.8mm) and December (8.3mm) 2018. Mortality in mussel beds was observed during February-April 2018 with increase in seawater temperature. Edible oysters, *C. madrasensis* and *S. cucullata* contributed 22.2% to the bivalve fishery. Clam production (1,875 t) recorded an increase by 84%, compared to 2017. *Meretrix casta* and *Villorita cyprinoides* contributed 92% to the fishery. Spat fall of *M. casta* was observed in March 2018 (9.8mm), June-August (6mm) and in November 2018 (7.3mm) in Gurupura Estuary. Clams were transported to Karnataka from estuaries of Kerala, Tamil Nadu and Andhra Pradesh.

Tamil Nadu: Bivalve production from Tamil Nadu and Pondicherry was estimated at 1,441 t. Clams contributed 50.6% followed by mussels (26.1%) and oysters (23.3%). In South Tamil Nadu, there was 81% reduction in clam fishery. Effluent discharge from shrimp farms into the Athankarai Estuary, Ramanathapuram caused skin irritations in fishers, consequently resulting in reduction in the fishing effort. In Kanyakumari District *Perna indica* dominated the


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1. Drying of bivalve shells along Subarnarekha Estuary, Odisha
2. Shucking of oyster meat in Bheemli Estuary
3. Sorted bivalve shells for marketing
4. Juvenile clam exploitation in Vembanad Lake

fishery. In Chinnapalam, the bivalve resource comprised of *Gafrarium tumidum* (30%) and *Donax* sp. (70%). *C. madrasensis* (74%) formed the major fishery followed by green mussel (26%) in North Tamil Nadu from Tiruvallur and Kanchipuram districts

M. Casta (83%) dominated the fishery followed by *M. Opima* (17%) in Chunnambar Estuary, Puducherry. Peak spawning in *M. Casta* was observed during August-December.

Andhra Pradesh: Bivalve landings from Kakinada Bay and Bheemli Estuary was estimated at 1,071 t. *M. meretrix*, *Tegillarca* (*Anadara*) sp. and *C. madrasensis* dominated the fishery. In Bheemli, peak spawning season of *M. meretrix* was observed during August-September and April-May, and spat fall during December-January and May-June. In *C. madrasensis* spawning season was during July-August & January-March and spat fall from October-January and June.

Odisha: Clam fishery in Subarnarekha Estuary was estimated at 33,828 t in 2018. Nearly 600 fishers from 6-8 villages in Balasore District collected 250-450 kg/day by handpicking. *Meretrix* species were dominant in the fishery. Live clams were exploited for shells and marketed in West Bengal.

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Kerala: Clams formed 88.1% of bivalve production in Kerala followed by mussels (6%) and edible oysters (5.9%). Black clam, *Villorita cyprinoides* was the most important clam species exploited in India (56.23%), with Vembanad Lake contributing 91% to the fishery.

The *V. cyprinoides* catch and catch rate in Vembanad increased by 21% and 38.4% respectively in 2018. Heavy exploitation of juvenile black clams (<20 mm) (2,464 t) was recorded in Panavally area of Vembanad Lake due to the high demand in lime and poultry industries. More than 140 canoes harvested a minimum of 200 kg/day for four months. Minimum size of *V. cyprinoides* in the fishery decreased from 17.3 mm in 2017 to 6.5 mm in 2018. In spite of the recommendations from the Government, the juvenile clam exploitation continues as a lucrative fishery meeting the demand in the shell industry.

The *P. malabarica* production in Ashtamudi Estuary estimated at 5,210 t, decreased by 53.5% in 2018, which was below the LRP of 6,000 t. Catch rate was also decreased by 29%. Length range in the fishery, 26.1-33.5mm, was above the minimum legal size of 20mm. Fishing ban continued during December 2018-February 2019. Clam biomass survey in Ashtamudi Lake found that a major portion of the Lake bottom close to the sea was covered with sea lettuce *Ulva* sp. and in some places, it had smothered the clam beds.

Input for 4th Surveillance Audit Process for the MSC certified *P. malabarica* fishery of Ashtamudi Lake was provided by ICAR-CMFRI.

Green mussel landings in the major landing centres of Malabar area was estimated at 3755 tonnes. Moodadi showed the highest landings (615.4 t) followed by Elathur (510.7 t) and Chaliyam (493.9 t). *V. cyprinoides* dominated the clam fishery.

Estimated catch of brown mussel, *Perna indica* from Vizhinjam- Kovalam was 458 t. Fishery was dominated by the length group of 64-66 mm followed by 68-70 mm. Highest spat fall was observed in July and August. Self-imposed fishing ban on collection of small mussels was imposed by local fisher group for resource management. Clam fishery in Muthazhapoli Estuary was dominated by *P. malabarica.* Spat fall began in September (2.6mm-18mm) and continued till November 2018.

Ornamental Gastropods

Objectives: Exploited resources of various marine gastropods are monitored in different states, ie., Andhra Pradesh, Tamil Nadu, Kerala and Maharashtra. Observations on the shell craft industry was carried out.

State wise gastropod landings

Andhra Pradesh

The total gastropod production from the Kakinada regions was about 486.5 tonnes with an average CPUE of 37.16 Kg. The total catch from Visakhapatnam Fishing

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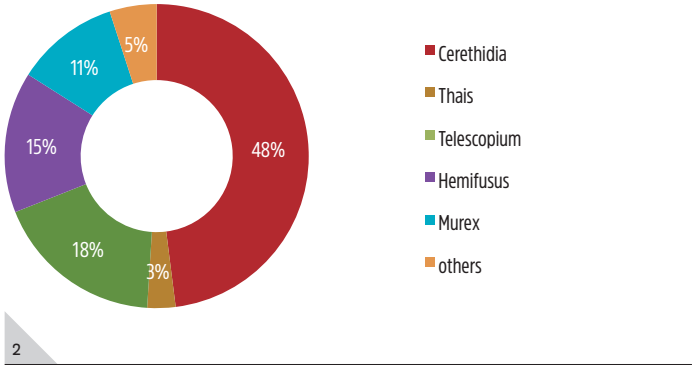
Sustainable management of fishery resources: Ornamental Gastropods



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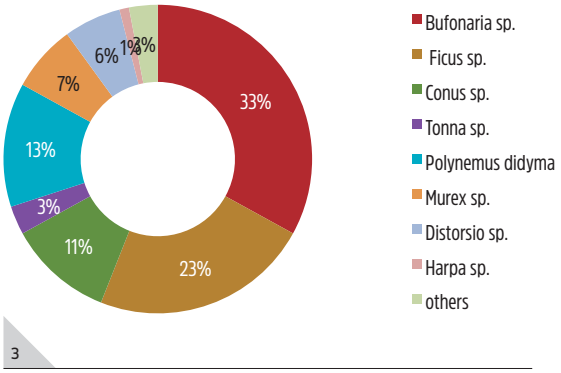

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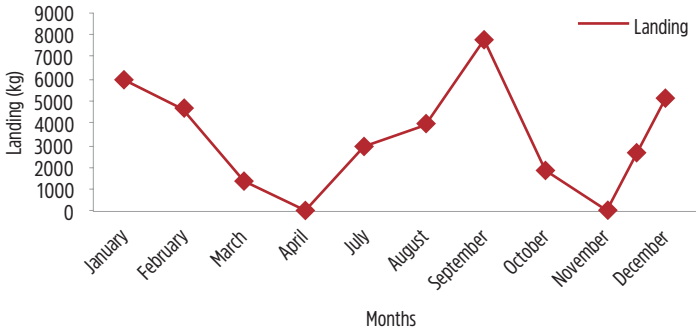

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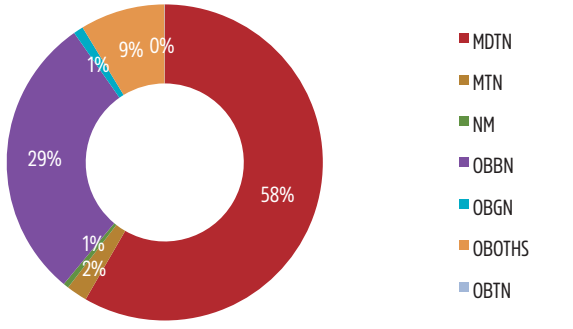

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1. Charonia tritonis-Trumpet shell - Another imported gastropod of Shell craft value.
2. Gastropod fishery of Kakinada
3. Gastropod fishery of Visakhapatnam
4. Month-wise landing of gastropod
5. Gearwise Landing of gastropods - Chennai

Harbour was 5991.75 Kg. The major contributor in the trawl catch were *Bufonaria* species. Other species include *Ficus* sp., *Conus* sp., *Natica vitellus*, *Tonna* sp., *Distorsio* sp. *Hemifusus* sp. *Stellaria solaris etc*

Tamilnadu

Chennai

Total estimated landing of gastropods at Chennai Fisheries harbour was 33 t as by-catch in trawlers. The fishery comprised of 30 species and *Babylonia* spp. formed the major fishery (37%). The other regularly landed gastropods are *Ficus* spp., *Bursa* spp., *Turittella* spp., *Tonna dolium*, *Nassarius dollium*, *Conus* spp., *Phalium* spp., *Rapana rapiformes*. High export demand prevalent for Babylonia in China, Hong Kong and Thailand

Tuticorin

Tuticorin gastropod landing in 2018 is 414 tonnes, which showed 9 % increase in gastropod catch compared to previous year. The highest catch recorded in the months of October and December and lowest catch recorded during April. Among the different landing centres 69 % of gastropod catch is from Kalavasal by diving and 21 % of the catch is from Kayalpattinam by gill net. Tuticorin Fishing Harbour contributed very meagre amount in the total landing of Tuticorin District.

Sustainable management of fishery resources: Ornamental Gastropods

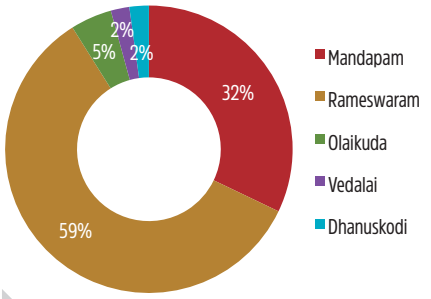
Size ranges of gastropod in the fishery

Mode of exploitation		T.pyrum	C.ramosus
Diving (Kalavasal)	Length (mm)	122-188(150)	134-202(174)
	Weight (g)	255-856(477)	343-1060(634)
Gill net (Kayalpattinam)	Length (mm)	100-182(154)	108-203(174)
	Weight (g)	165-823(186)	165-823(186)

2

Ramanathapuram

In Ramanathapuram, the total gastropod landing was 1364 tonnes recording a 41 % decrease in gastropod catch compared to previous year. The highest catch (141 tonnes) and lowest catch (11 tonnes) observed in July and May respectively. In Manadapam and Rameswaram, maximum catch contribution is by *Strombus* and *Natica* spp.



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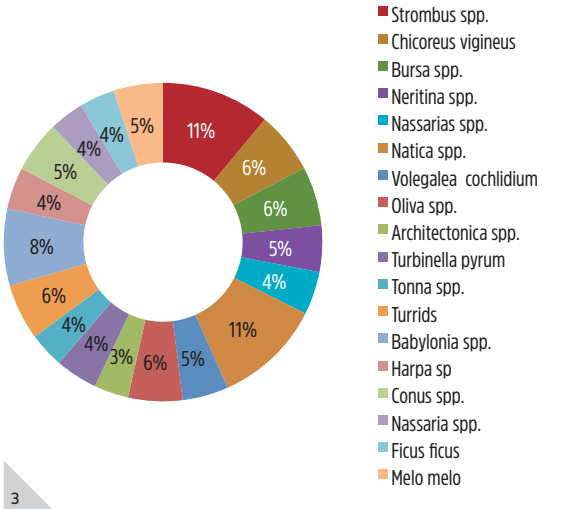
Gastropod opercula trade :The total estimated gastropod opercula trade consisting of three species ie., *T. pyrum, C. ramosus* and *L. Lambis* in 6 landing centres was 2,83,693 nos ,4,20,769 nos and 85,62,649 nos respectively.

Annual estimated gastropod landing by Trawlers

Centre	2018	2017	2018	2017	2018	2017
		Catch(t)		CPUE (Kg/unit)		CPUE (Kg/hr)
Rameswaram	804	1092	12.5	18	0.5	2
Mandapam	438	978	7.8	18	0.3	1.5



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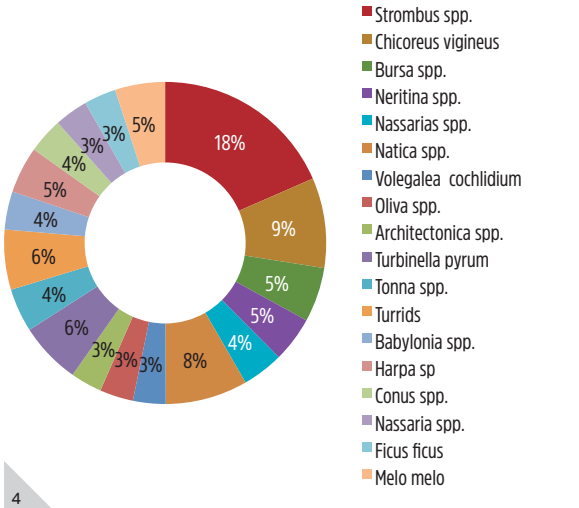

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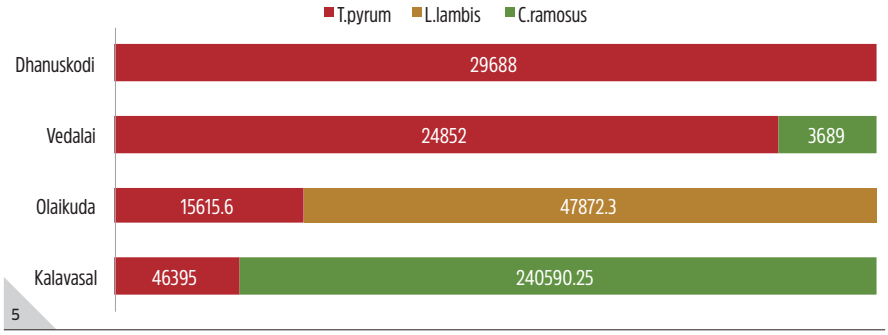
Sustainable management of fishery resources: Ornamental Gastropods

Annual estimated gastropod landing by Diving

Centre	Craft	Catch(t)	CPUE (Kg/ unit)	CPUE Kg/ person	Species composition (%)			Fishing month
					T.pyrum	C.ramosus	L. lambis	
Vedalai	Vallam	29	24.2	4.8	87	13	0	Jan- March Nov-Dec
Olaikuda	Vallam	52	41.2	10.3	21	0	79	April-Oct
	Catamaran	11	5	5	42	0	58	April-Oct
Dhanuskodi	Catamaran	30	46	9.2	100	0	0	Jan-March Nov- Dec
Kalavasal	Vallam	287	41.3	8	16	84	0	All months



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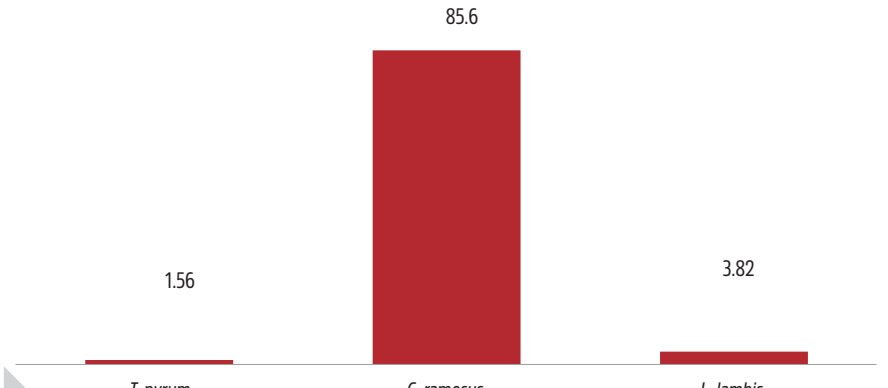

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Annual estimated catch at Kayalpattinam by Bottom set gill net

Centre	Catch(t)	T .pyrum	C. ramosus	CPUE (Kg/ unit)
Kayalpattinam	127	42	58	11

Exploitation of fossilized chank at Kalavasal

Centre	Craft	Gear	Catch (t)	CPUE (Kg/unit)	CPUE (Kg/ person)	Fishing Month
Kalavasal	Vallam	Diving	203	16	2.5	All months

1. Percentage of Gastropod landing - Ramanathapuram
2. Busycon spp - A widely used imported gastropod in shell industry
3. Species composition -Mandapam
4. Species composition- Rameswaram
5. Species composition of gastropod species exploited by diving
6. Gastropod opercula trade at Tuticorin (in lakhs)

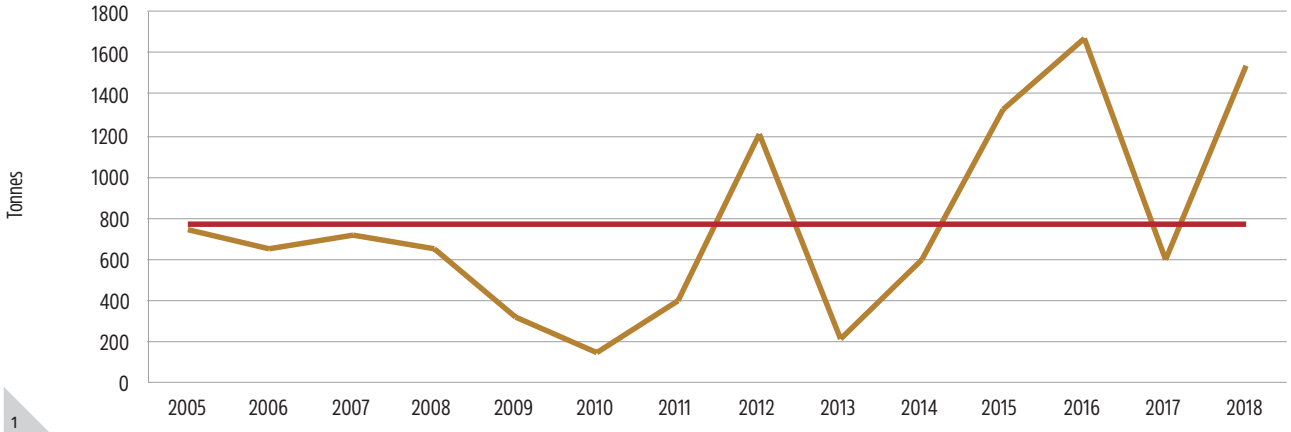
Sustainable management of fishery resources: Ornamental Gastropods

Kerala (Kollam)

Total estimated gastropod landings was 1534.5 t. The contribution by two main gears -87.5% by Single day trawl net (MTN) and 12.2 % by Multi-day trawl net (MDTN *Babylonia spirata* (78.63 %) and *B. zeylanica* (7.52 %) were the dominant species in the catch forming 86.15%.

Biology of Babylonia spirata

Babylonia spirata length ranged from 19.5 to 48.5 mm. Smallest size appeared in June which might be the spawning



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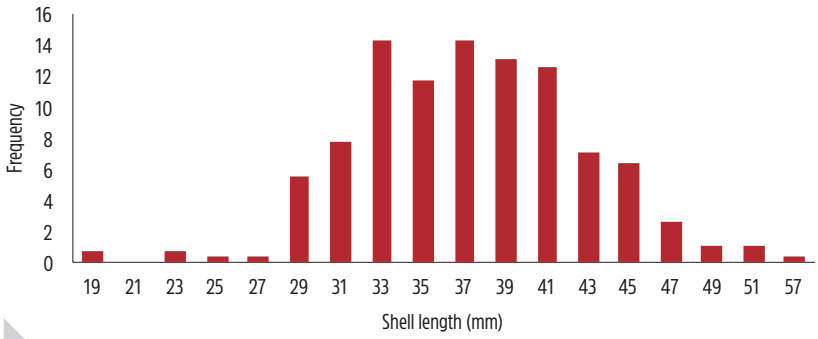

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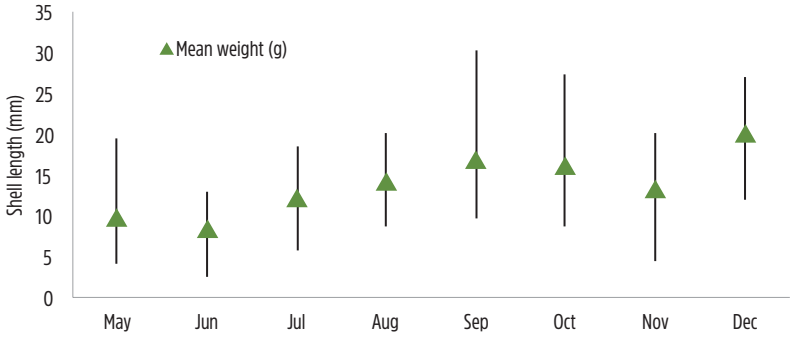

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1. *Gastropod Catch Kerala - Trend*
2. *Length frequency distribution of Babylonia spirata*
3. *Month wise mean shell length of Babylonia spirata*
4. *Cluster of ornamental gastropods*
5. *Size ranges of fossilized T. pyrum in the exploitation*
6. *Harpago chiragra-New initiative for controlled breeding*


4


5


6

Species	Size range (mm)
Tibia curta	36-101
Bufonaria echinata	29-68
Murex tribulus	31-40
Natica sp	19-20
Indothais lacera	32-41
Babylonia spirata	23-52
Indothais sp	28-35
Turricula javana	18-48
Nassarius sp	10-18

season of this species. The largest size obtained on April month.The total weight ranged between 2.13 and 26.35 g, and meat weight ranged from 1.67–12.97 g. The population was dominant by females; the sex ratio (Male to Female) was 1:1.4.

Biology of Bursa spinosa

Length ranged -30.66 to 81.98 mm. Smallest size appeared in May which might be the spawning season. The largest size obtained during August. The total weight ranged between 3.96 – 39.7 g, and meat weight ranged from 1.57 –15.8 g.

Maharashtra (Mumbai)

Gastropod fishery monitored at Mumbai and the size ranges of the following gastropods were recorded.

Elasmobranchs

Research projects: DEM/ELS/11 & DEM/ELS/SUB/11

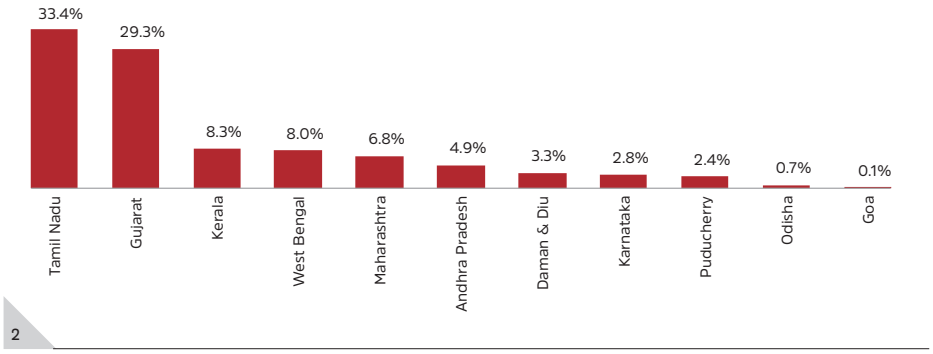
Fishery: Elasmobranch landings in India during 2018 was 42,117 t, increasing marginally by just under 2% from the previous year. Tamil Nadu and Gujarat were the major contributors. The west coast accounted for 50.5% of the landings and the east coast, 49.5%. Tamil Nadu, Puducherry, Gujarat and Daman & Diu together accounted for 68.4% of the total elasmobranch landings in the country.

The mechanised and motorised sectors contributed to 84 and 15% of the elasmobranch landings, respectively. The contribution of non-motorised sector

1

Sustainable management of fishery resources: Elasmobranchs

1. Silky sharks - *Carcharhinas falsiformis*
2. State-wise contribution (%) to all-India elasmobranch landings in 2018
3. Contribution of fishing sectors (%) to all-India elasmobranch landings in 2018
4. Composition of elasmobranch landings in 2018



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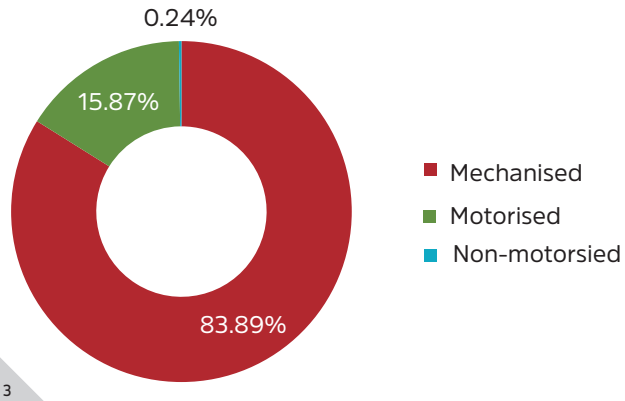

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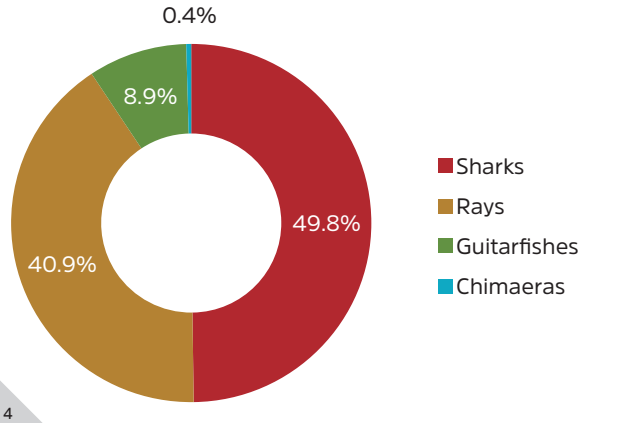

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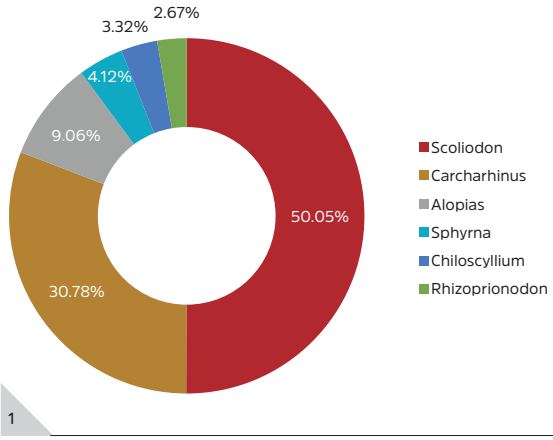
was negligible. Trawl nets contributed to 57.8% of the landings by the mechanised sector, gillnets, 17.2% and hooks & lines, 1.4%. Boats that operated combinations of different gears landed 18.3% of the annual elasmobranch landings.

Catch per unit effort (CPUE) was highest for boats that operated combinations of different gears (mostly gillnets and line gear), averaging 437.4 kg. The CPUE was 126.6 kg for mechanised hook & line operations.

Sharks and rays together formed 90.7% and guitarfishes formed 8.9% of the elasmobranch landings. Chimaeras formed 0.4%. Sharks registered a fall by 15%, guitarfishes by 12% and rays by 43% from 2017.

Over 93% of the shark landings were formed by six genera: *Scoliodon*, *Carcharhinus*, *Alopias*, *Sphyrna*, *Chiloscyllium* and *Rhizoprionodon*. Over 93% of the ray landings were constituted by the genera *Himantura*, *Dasyatis*, *Mobula*, *Manta*, *Neotrygon*, *Pateobatis* and *Aetobatus*. Over 85% of the ray landings were formed by the two families Dasyatidae and Mobulidae. The family Dasyatidae is represented mainly by the genera *Dasyatis*, *Himantura*, *Maculabatis*, *Neotrygon* and *Pateobatis*. Guitarfish

Sustainable management of fishery resources: Elasmobranchs



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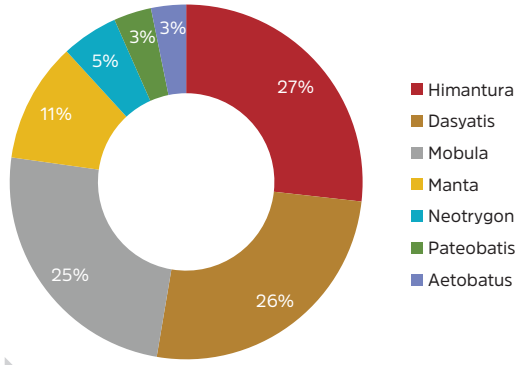

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Species composition of sharks landed at Cochin Fisheries harbour in 2018

Species	% in total sharks landed
Carcharhinus falciformis	36.7
Alopias pelagicus	10.5
Sphyrna lewini	9.6
Carcharhinus amblyrhynchoides	8.4
Carcharhinus longimanus	7.2
Carcharhinus limbatus	6.9
Galeocerdo cuvier	3.4
Carcharhinus leucas	2.6
Isurus oxyrinchus	2.6
Alopias superciliosus	2.5
Carcharhinus albimarginata	2.3
Stegostoma fasciatum	1.5
Prionace glauca	1.3
Echinorhinus brucus	1.0
Carcharhinus sorrah	0.9
Sphyrna zygaena	0.8
Carcharhinus amblyrhynchos	0.5
Nebrius ferrugineus	0.5
Triaenodon obesus	0.5
Isurus paucus	0.3

Biology of species common in the fishery

Species	Coast	Size range	Mean size	Sex ratio	Gut contents
Scoliodon laticaudus	NW	17-61 cm, TL	36 cm, TL	**1**:0.96	fish, shrimp, crab, stomatopod, cuttlefish
Scoliodon laticaudus	SW	24.5-70 cm, TL	48.41 cm, TL	**1**:1.81	squid, fish, stomatopod
Carcharhinus sorrah	SW	75-106 cm, TL	85.57 cm, TL	**1**:1.13	fish
Carcharhinus limbatus	SW	68-146 cm, TL	82.8 cm, TL	**1**:1.15	fish
Chiloscyllium griseum	SW	46-87 cm, TL	59.62 cm, TL	**1**:0.5	fish, shrimp
Iago cf. omanensis	SW	30.5-91.5 cm, TL	51.71 cm, TL	**1**:1.79	fish, shrimp, octopus
Himantura imbricata	NW	14.5-32.5 cm, DW	20.5 cm, DW	**1**:0.5	shrimp, fish
Himantura imbricata	SE	11-23 cm, DW	18.1 cm, DW	**1**:1.2	shrimp, fish, crab
Pateobatis bleekeri	SE	30-150 cm, DW	75 cm, DW	**1**:1.6	octopus, shrimp, crab
Neotrygon indica	SE	10-40 cm, DW	27.9 cm, DW	**1**:1.4	shrimp, fish
Neotrygon indica	NE	10-41.9 cm, DW	29.2 cm, DW	**1**:0.85	shrimp, fish
Rhinobatos lionotus	SE	45-61.5 cm, TL	29.2 cm, TL	**1**:6.1	fish, stomatopod, crab, shrimp

Sustainable management of fishery resources: Elasmobranchs

1. Composition of sharks landed in 2018 – major contributors
2. Composition of rays landed in 2018 – major contributors
3. Crocodile shark landed at Dummulapeta near Kakinada
4. Pregnant bull shark landed at Beypore, Kerala

3

4

landings were dominated by the genera *Rhinobatos* and *Glaucostegus*.

Cochin Fisheries Harbour continued to be a major hub for shark landings in the country. Twenty species of sharks were landed in good number during the year. The sharks were mostly landed by boats operating multiday gillnets and line gear. There has been, however, a change in the operational base from Kochi to southern Tamil Nadu.

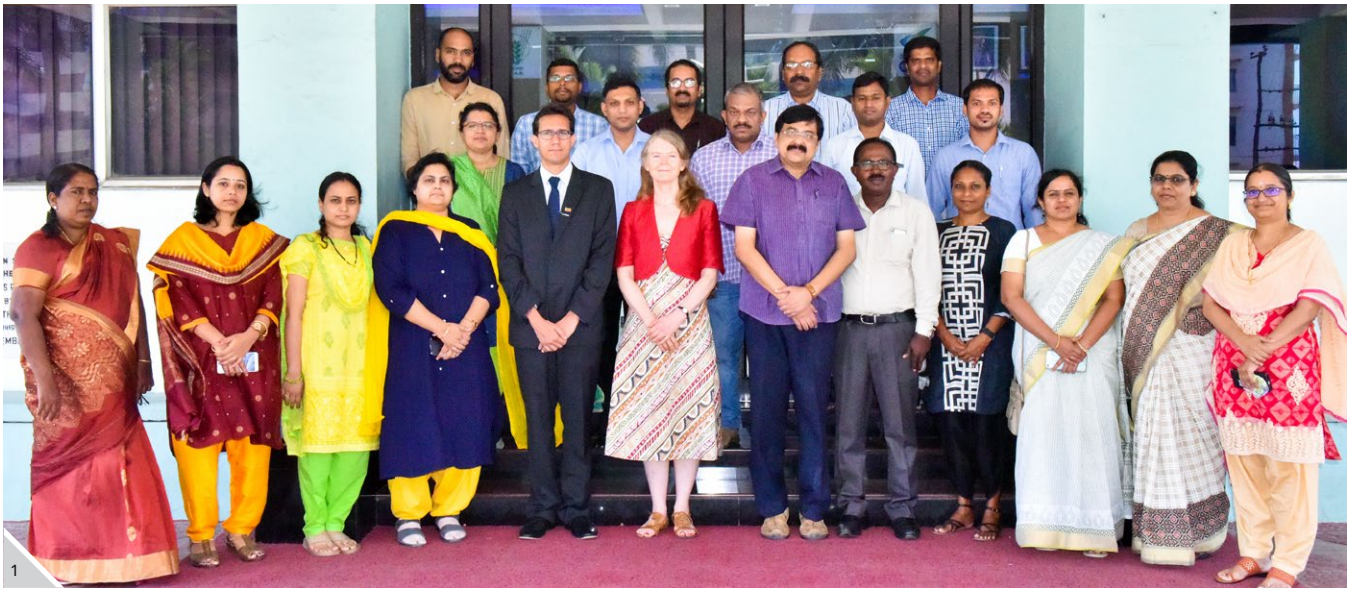
Landings of juvenile sharks: Landings of juveniles of *Carcharhinus falciformis* and *C. amblyrhyncoides* was observed during 2018. About 84% of the annual catch of *C. falciformis* consisted of individuals below the reported size at first maturity, with the highest juvenile landings during December (97%) followed by October (94%). Juveniles of hammer head shark, *Sphyrna lewini* measuring 40 to 90 cm in total length, *Mobula japanica*, *Himantura gerrardi* and *Rhina ancylostoma* were also landed as bycatch by multiday trawlers and hook & line fishing along north Kerala coast.

Rare and unusual landings: Unusual landings of crocodile shark *Pseudocarcharias kamoharai* were noticed at Visakhapatnam and Kakinada in Andhra Pradesh and at Chennai in Tamil Nadu.

A female bull shark, *Carcharhinus leucas* over 350 kg weight was landed at Beypore fishing harbour on 24th January 2019. The shark had 12 full-term pups. Unusual landing of *Carcharhinus spp.* (mainly *Carcharhinus falciformes* and *C. leucas*) along the Thiruvananthapuram coast was noticed during 2018-19. In the case of bull shark, the catch showed a hike from 122 to 26,319 kg during 2018. Peak landing was during March-April and the average weight range was 210-300 kg.

CITES-NDF Workshop: A CITES Non-Detriment Findings Workshop for Thresher and Silky Sharks was jointly organized by Blue Resources Trust, Sri Lanka and ICAR-CMFRI during 16-20 April 2018, at Kochi. Dr. Sarah Fowler, *Scientific adviser, Vice Chair for International Treaties, Save Our Seas, International Union for Conservation of Nature (IUCN)* and Dr Daniel Fernando,

Sustainable management of fishery resources: Elasmobranchs



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Co-founder, Blue Resources Trust were the expert consultants. Non-Detriment Findings (NDF) documents on silky and thresher sharks for the Indian Ocean have been prepared.

Socio-economics & Value chain study: A survey across fishing communities that are directly or indirectly involved in landing sharks (as targeted fishes or bycatch) indicated that 75% of fishermen are concerned about the future of the sharks, 69% evinced keen interest in enforcing regulations regarding harvesting of large sharks and 48% of the fishermen suggested that sharks should be protected. Almost 73% of the fishermen expressed that they would like to be consulted in government decisions regarding shark conservation.

The cost per trip incurred for catching elasmobranchs was found to be lower when targeted than as bycatch. Net operating ratio for targeted elasmobranch fishing was 98.3 on average, while net operating ratio for elasmobranch bycatch was 91.5 on average. The productivity of fishing units (gross ratio) averaged 0.296 ranging from 0.096 in Maharashtra to 0.607 in Karnataka for targeted elasmobranch fishing. The gross ratio of fishing units taking elasmobranchs as bycatch was 0.444 on average, ranging from 0.185 in Karnataka to 0.955 in Tamil Nadu.

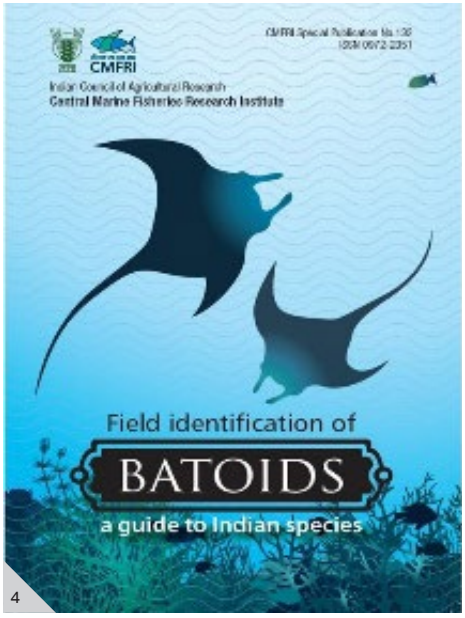
There is wide variation in marketing chain of elasmobranchs across India, ranging from direct sale to auctioneers (in Andhra Pradesh) to a much more complex chain involving retailers, vendors and wholesalers (Tamil Nadu, Maharashtra) with products travelling thousands of kilometers, even up to the north-eastern hill states. There is a great reluctance to share trade information about sharks. Most of the exporters (72%) were well aware of the protected species. Fresh meat price varies with species and size. While *S. laticaudus* is sold for ₹ 40-80/kg in fresh condition, juveniles of other sharks like *Carcharhinus* spp. *and Rhizoprionodon* spp. are sold for ₹ 250-500/kg. Dried shark meat is sold for up to ₹ 600-800/kg. Traders and exporters who earlier dealt with only sharks have now taken up combination trade, post shark fin export ban scenario.

Database on landings of protected elasmobranchs: Surveys were conducted to understand the status of protected species in the coastal states. Accidental catch of one whale shark *Rhincodon typus* was reported at Mangalore in the month of November 2018. A juvenile whale shark, *R. typus* which was caught in the inboard ring seine off Tanur, Kerala by fishermen on 17th September 2018 was brought to the shore and released back live into the waters. Surveys revealed there is an increase in sightings of whale sharks in the north eastern Arabian Sea and north western Bay of Bengal.

A national survey on "Awareness status and perception of fishermen on protected elasmobranchs" was conducted to understand the present and historical occurrence pattern of different species and their cultural importance. Whale shark, sawfishes and giant guitarfish were recognized by all respondents. In Maharashtra and West Bengal alone 7

Sustainable management of fishery resources: Elasmobranchs

1. Participants of the CITES NDF workshop
2. Juvenile whale shark caught and released at Tanur
3. CMFRI shark research team examining saw fish rostrums in Maharashtra
4. A field guide to Indian species of batoids



and 13% of the respondents recognized *Glyphis* spp. Several fishing communities had a religious/cultural relation with protected species like whale shark and sawfishes. While historically the whale shark was revered and used to be released unharmed, sawfish meat was utilized and rostrum offered to temples, churches and mosques. The Vetal temple in Khanderi Island, Maharashtra, currently holds more than 30 rostrums. Most of the recent sighting/capture of saw fishes, in the last 5 years, have been from West Bengal and Maharashtra. Other than *Pristis pristis*, there are no recent confirmed record (>20 years) of *Anoxypristis cuspidata* and *Pristis zijsron* in the coastal areas of mainland India.

Awareness workshops: Awareness workshops on 'Conservation of elasmobranchs with an importance to protected species under the Indian Wildlife (Protection) Act (IWPA) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) listed species were conducted for fishermen at Malvan (Maharashtra), Contai (West Bengal) and Thoothukudi (Tamil Nadu). Pamphlets including colour charts of protected elasmobranchs under Indian Wildlife (Protection) Act, 1972 were distributed to enable fishers to identify and release them if accidently caught. Officials of the respective State Fisheries Departments and representatives from NGOs also participated in these workshops.

Field Identification of Batoids – a guide to Indian species: A concise, user-friendly field guide to 70 species of batoids has been prepared for the use of field staff, enforcement agencies, researchers, fishermen and traders to enable documentation of species-wise catches and identification of threatened and protected species.

New initiatives

A study on shark and ray non-fin commodities, in collaboration with FAO, Rome, has been initiated, to map the market chain across the country for non-fin products.

A study on reducing shark bycatch and managing shark resources in Gujarat, in collaboration with ICAR-CIFT and WWF-India has been initiated.

Stakeholder's consultations

CMFRI organised stakeholder consultation meetings at its headquarters and different regional and research centres during 2019 which were attended by fishermen/ farmers and their representatives, members of cooperative societies, officials from state and central government organisations, private and public agencies and scientific and technical personnel working in the field.

Veraval

The points emerged in the discussions were, need for expansion of fishing

grounds to deeper waters to sustain the fishery, partial conversion of trawling to longlining as per the scheme of the government, concern on targeted fishing for *Acetes* sp. by the trawlers, line trawling by Maharashtra vessels in waters off Gujarat which was likely to have a negative impact on sciaenid resources of the state. The fishermen are in favour of combination of vessels with four months trawling and longlining in other months.

Mumbai

The key issues discussed in the meeting were on increasing level of bycatch and juveniles in the trawl fishery and fishing of juvenile pomfrets by dolnets, fishing of broodstock of commercially important species hampering recruitment processes, need for addressing livelihood issues through developmental projects, drought package for fishermen in closed season, increasing level of plastic and effluent pollution, need for VMS in fishing vessels etc. While discussing the MLS of the species recommended by CMFRI, it was suggested to implement larger cod-end mesh, for which fishermen are not in favour. However, they favoured an extended closed season.

Karwar

The discussions focused on the cage farming activities promoted by CMFRI along Karnataka coast. The issues discussed were shortage of availability of good quality seeds of optimum stockable size, impact of water current in coastal waters, extension of permission for open water cage culture, need for subsidy in subsequent crops etc. CMFRI suggested the farmers to initiate the culture earlier than the current period practised and suggested to inform the requirement of feed for the entire crop in advance.

Stakeholders Meet at different centres

1. Veraval
2. Mumbai
3. Karwar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Sustainable management of fishery resources: Stakeholder's consultations

Stakeholders Meet at different centres

1. Calicut
2. Kochi
3. Vizhinjam
4. Tuticorin
5. Mandapam
6. Visakapatnam

Mangalore

The key issues that came up for discussions were conflicts between different sectors due to the implementation of ban order on bull trawling and light fishing by purse seines, lack of uniform ban period, pollution by industrial effluents, juvenile fishing, cleanliness and hygiene at landing centres etc. Fishermen suggested that the manufacture of diamond shaped mesh for cod end should be prohibited at the manufacturing end. The officials of the DoF, GoK have been trained and empowered to take necessary action to ensure better cleanliness and hygiene at all major harbours.

Calicut

The discussions mainly focussed on issues faced by mussel farmers along Malabar area including siltation and reduction in the depth of the estuaries, pollution by the effluents of some of the shrimp farms and fish processing companies, need for organising a marketing channel for edible oysters, mass mortality of mussels during April – May months. The concern on light fishing and harvesting mature squids using coconut spadix also were raised in the meeting.

Kochi

Elaborate discussions took place on the decline in the landings of small pelagics especially, oil sardine and the fishermen urged to elucidate the major reason for the same. It was reiterated that many factors contributed to the decline including *El-Nino* effect as well as over exploitation of the resources in the past. The MLS regulation in the state had a positive impact as the quantity of juvenile harvest of some of the resources has been reduced. It was suggested to undertake a socio-economic study on the fishermen who are likely to be affected by decline in oil sardine catch, Other suggestions raised by the stakeholders were implementation of MLS in neighbouring states, studying migration pattern of demersal fishes, feeding changes in oil sardine and impact of coastal pollution on fisheries etc.

Sustainable management of fishery resources: Stakeholder's consultations

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Vizhinjam

The suggestions extended in the meeting were to improve the infrastructure facilities at the fishing harbours and markets, facilities for distant marketing by fisherwomen, improved processing technologies for fishing villages, increase in monthly pension of fisherfolk senior citizen, reservation for fishermen children in Maritime Academies. The issue of marine pollution and destructive fishing methods practised along the coast also were discussed.

Tuticorin

The major viewpoints raised in the meeting were the concern over the harvest of juveniles by trawlers, conversion of trawlers to eco-friendly gears such as hooks and lines, shifting of closed season to November-December attributing natural calamities and breeding of pelagic fishes, strict implementation of TN Marine Fishing Regulation Act and ban of ring seines and pair trawling. Trawl fishermen demanded providing adequate postharvest facilities for the sustainable harvest of deep sea resources.

Mandapam

The fishermen pointed out some of the under/over estimates of the catch by CMFRI and some high value resources are directly going to export companies. However, it was informed that the institute does not estimate the catch but the landings which are actually landed in the landing centre.

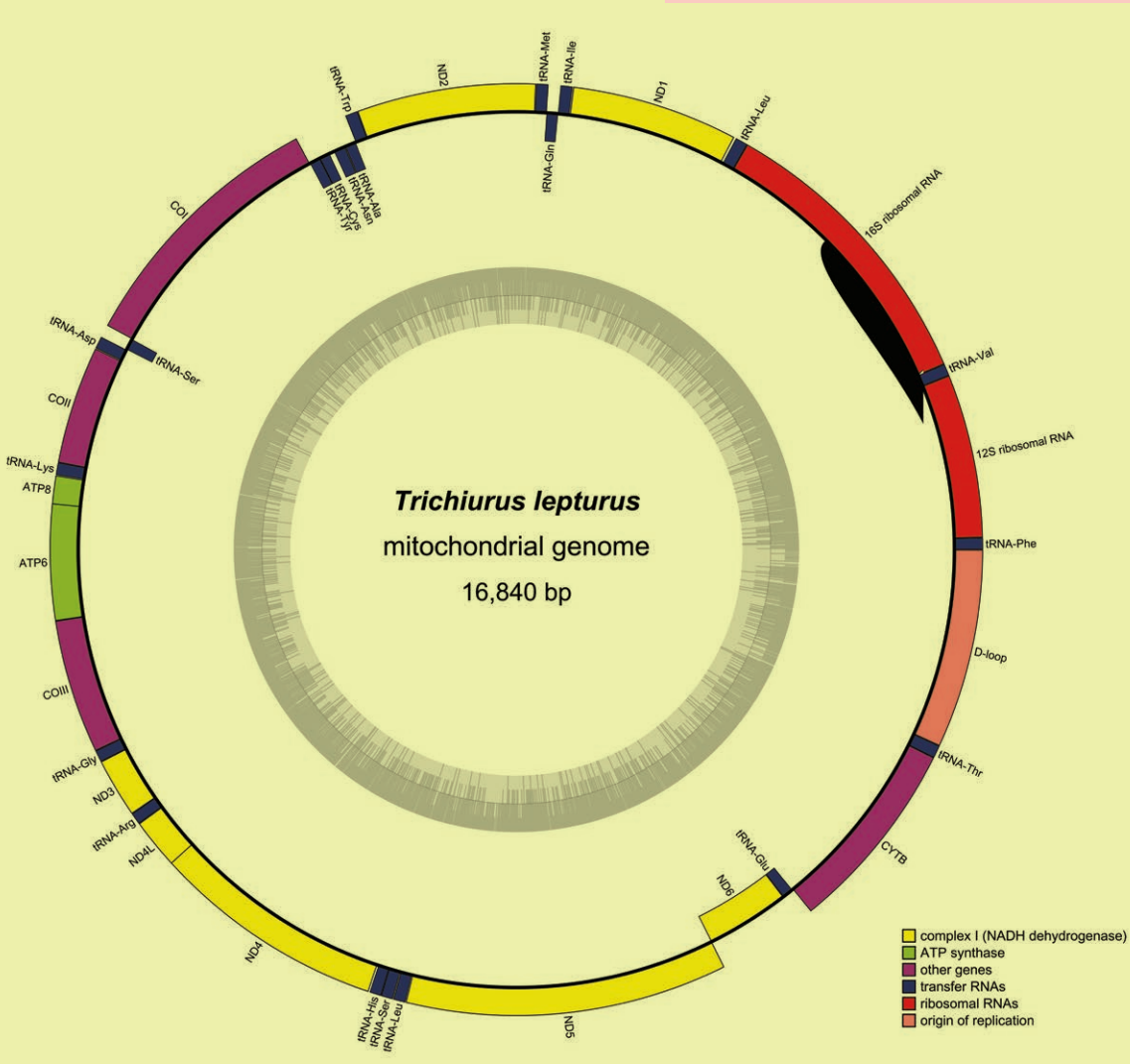
Visakapatnam

The points emerged in the discussions were, to include the traditional sector also in the seasonal fishing ban, increase the trawl ban subsidy, change in the mechanism of transferring fuel subsidy etc. Fishermen also urged to advertise and promote fisheries as practised in the case of poultry and diary sectors.

Genetics and Genomics

Characterization of the complete mitogenome of ribbon fish, *Trichiurus lepturus*

The complete mitogenome of ribbon fish, *Trichiurus lepturus* has been characterized. The entire mitogenome is 16,840 bp in length with 13 protein coding genes (ND 1–6 and 4L, CO I–III, ATPase 6 and 8, Cyt b), 2 subunit ribosomal RNA genes (12S rRNA and 16S rRNA), and 1 control region similar to other vertebrates.



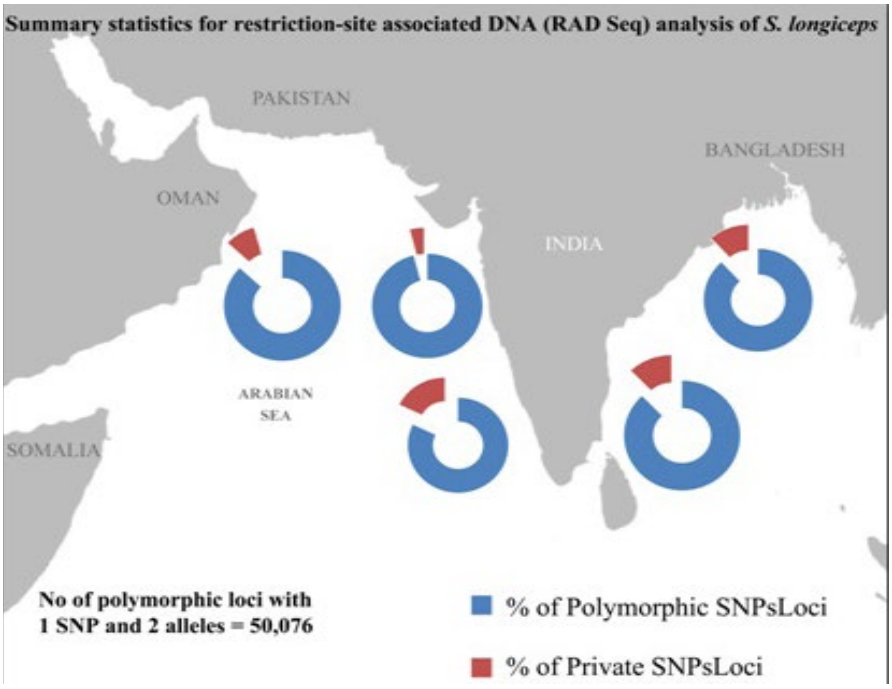
Whole genome sequencing of Indian oil sardine, *Sardinella longiceps*

Whole genome sequencing of Indian oil sardine, *Sardinella longiceps* has been initiated using Nanopore and Illumina Hiseq 2500 sequencing machines. Paired End and Mate pair libraries were constructed at 100X and 50X coverage. Gene predictions, assembly and annotations are in progress using different software packages.

Genetic and genomic investigations in Indian oil sardine, *Sardinella longiceps*

Genetic tagging of spawning populations of Indian oil sardine, *Sardinella longiceps* along the Indian coast provided evidence for the presence of distinct spawning components along south west and south east coasts of India.

Population genomic investigations in Indian oil sardine provided evidence for locally adapted populations. Presence of outlier loci correlating with geographical regions was observed indicating adaptive genomic evolution. These loci could be further used as geographical tags for sardine populations.



Population genetic structure of scalloped hammerhead shark, *Sphyrna lewini*

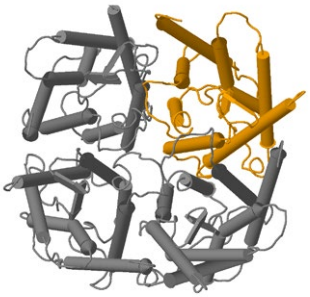
Population genetic structure of scalloped hammerhead shark, *Sphyrna lewini* was investigated by collecting samples from East and West coasts of India. Population genetic structure was not significant within the Indian coast. Comparison between *S. lewini* populations of Pacific and Atlantic oceans revealed basin level genetic differentiation with the presence of 3 haplogroups. A recent reduction in effective population size and genetic diversity calls for stricter implementation of conservation measures.

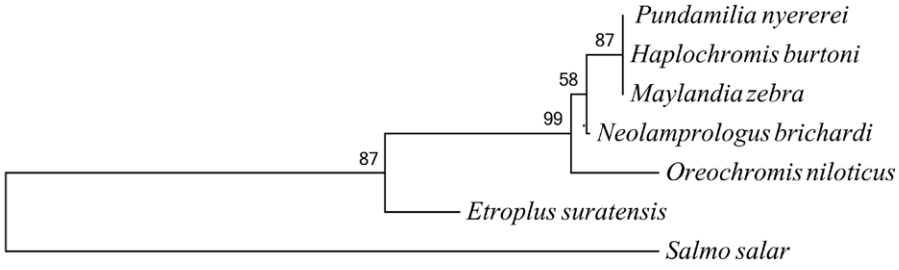
Molecular confirmation of hybrid identity in clown fishes

Identification and confirmation of hybrids of *Amphiprion ocellaris* and *A. percula* (♂*A. ocellaris* x ♀*A. percula* and ♀ *A. ocellaris* x ♂ *A. percula*) has been carried out using mitochondrial and nuclear markers. Hybrids recorded distinct band pattern as compared to parents.

Isolation and characterization of stress genes from *Etroplus suratensis*

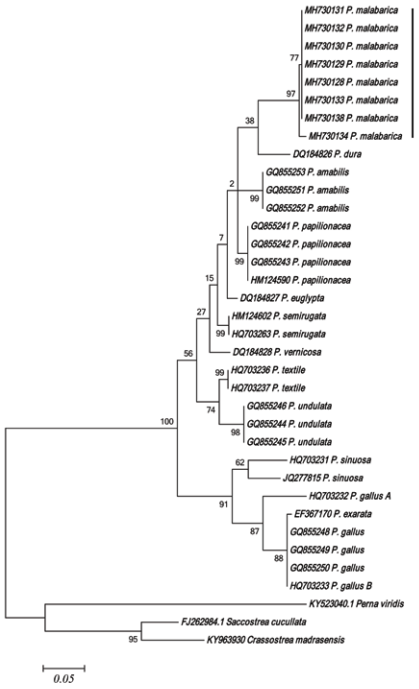
Isolation and characterization of *Aquaporin 1 (AQP1), sodium/potassium transporting ATPase subunit alpha-1 (Na/K-ATPase α1), Heat Shock Protein 90 (HSP90), Heat Shock Cognate 71 (HSC71), Osmotic Stress Transcription Factor 1(OSTF1) and Transcription Factor IIB (TFIIB)* genes from the euryhaline fish *Etroplus suratensis* has been carried out. These genes are candidate genes involved in stress responses of fishes.





Molecular and Morphological investigations on species identity of *Paphia (Protapes) malabarica*

Morphological and molecular investigations provided evidence for distinct species status of *Paphia malabarica* indicating that synonymy with *Paphia (Protapes) gallus* is invalid and the name *P. malabarica* has to be retained. The recent reassignment of the Ashtamudi clam into the genera *Marcia* and species *Marcia recens* has also been proved to be invalid as the study lacked molecular evidence.



Forensic investigations on sharks and whales

Forensic investigations were carried out using molecular tools to identify 75 shark fin samples seized by Directorate of Revenue Intelligence, Mumbai. The samples belonged to the species, *Glaucostegus granulatus*, *Lamiopsis temminckii*, *Carcharhinus falciformis*, *C. brevipinna*, *Alopias superciliosus*, *Centrophorus granulosus*, *Triaenodon obesus* and *Carcharhinus melanopterus*. Forensic identification of stranded whale handed over by Mangrove cell, Mumbai was carried out using molecular tools and the whale was identified as *Balaenoptera edeni*.

1. Mapping and Annotation statistics of assembled transcripts
2. Species distribution of assembled transcripts
3. Gene Annotations for transcriptome of Perna viridis

Investigations on genetic divergence in brood stock of Cobia, *Rachycentron canadum* using microsatellite markers

Investigations on genetic divergence are in progress in the brood stock of Cobia *Rachycentron canadum* using microsatellite markers. The samples were collected from Tamil Nadu and Kerala waters. The following set of primers was used for amplification of the microsatellite loci.

Microsatellite	Primer sequence (5'-3')	TA	Size
Rca 1B-F06	CAAGCAAATGCGTGGCCGA CGTTAGCAACCACACGAGCTTG	60	260-300
Rca 1B-H09	CATGTTATTCTCCAACTCATGG GTGTATCCGCATACTTTCAG	48	176-224
Rca 1-A11	CTACAGTGGTGTTCCCTGTTAG CAGTACATAGAGAAACAGGAGG	55	167-201
Rca 1-C04	GACATCAAGTGGCACTTTG CACTAAACTTGTTCCTCCTG	48	223-253
Rca 1-E06	GGCACCAATCACTCACTACTG TGTTGAGGTCTATCAGTGCC	55	167-181

De novo transcriptome analysis of *Perna viridis*

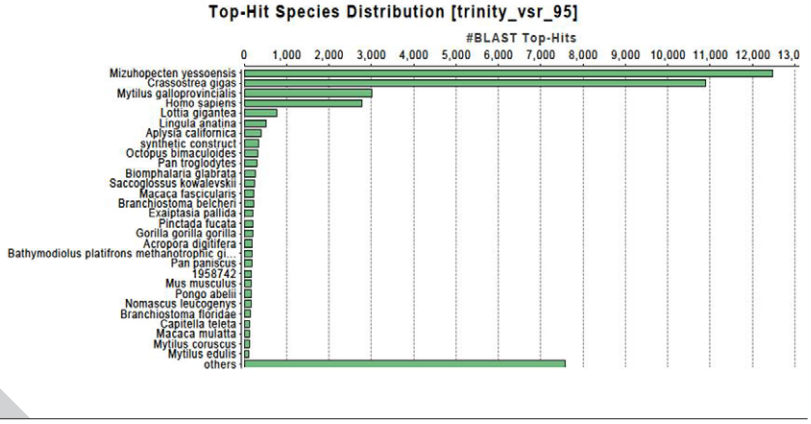
The transcriptome profiling and *de novo* assembly of transcripts of digestive gland in green mussel *Perna viridis* was carried out to unravel the genes expressed that are involved in major biochemical pathways. The Illumina sequencing yielded 28526893 high quality reads. The adapters were trimmed down to bring down the number of quality reads to 18929046. The *de novo* assembly using Trinity generated 140222 contigs. The length of assembled contig ranged from 201 bp to 32936 bp with an average contig length of 854.72 bp and N50 length of 1685 bp.

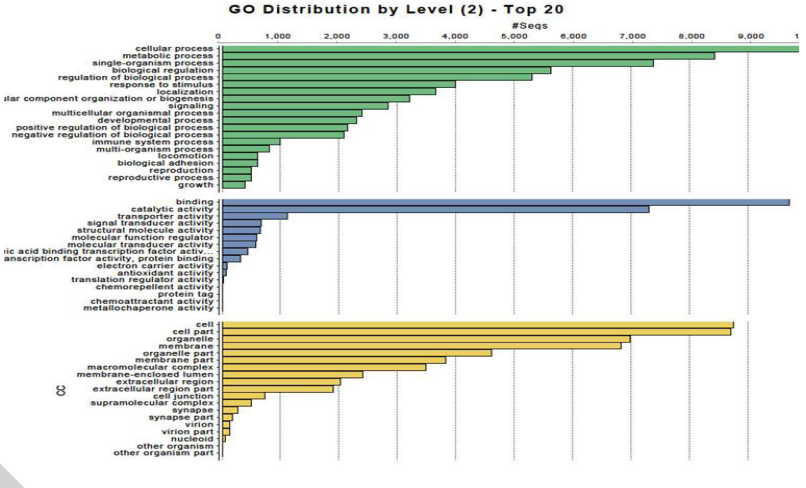
Functional annotation:

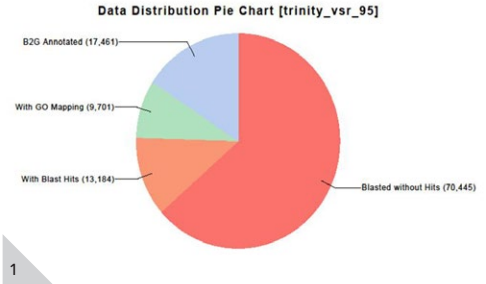
The BLAST search was performed against NCBI nr (non-redundant) database with 40346 assembled transcripts returning with blast hits. Out of 40346 assembled transcripts, 17461 transcripts have been mapped and annotated.

Summary of assembled transcriptome of *Perna viridis*.

Parameter	Number
Total Sequences	28526893
Total number of filtered reads	18929046
Total number of assembled contigs	140222
Number of assembled transcripts after clustering	110791
N50 (bp)	1685
Minimum contig length (bp)	201
Maximum contig length (bp)	32936
Average contig length (bp)	855
Total length in contigs (bp)	94695111







The BLAST search of assembled transcripts had its best similarity with *Mizuhopecten yessoensis* (Giant Scallop) sequences followed by *Crassostrea gigas* (Pacific Oyster) *and Mytilus galloprovincialis* (Mediterranean mussel) respectively.

Out of 40346 assembled contigs with BLAST hits, 17461 were found to have putative protein domains. The Gene Ontology (GO) terms were assigned to the assembled transcripts according to NCBI nr database. The number of genes associated with binding and cell were found to be more in molecular functions and cellular component respectively.

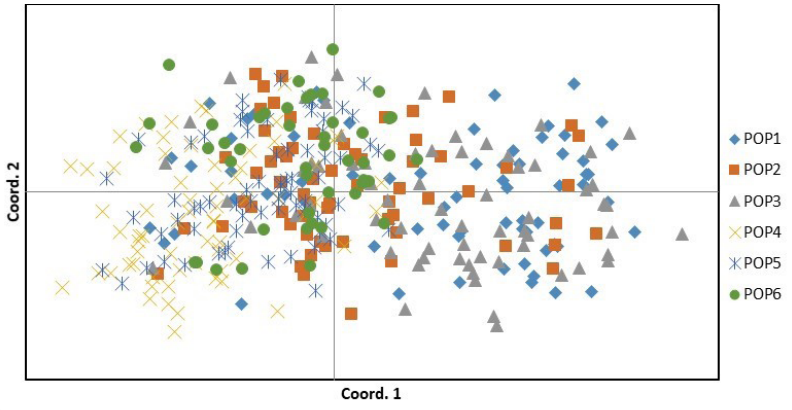
The KEGG pathway annotation analyses of the assembled transcripts assign the transcripts with 138 KEGG pathways involved in different metabolic functions. The de novo assembly of transcriptome of digestive gland of *P. viridis* gives an in-depth understanding of the basic mechanisms involved in the detoxification of pollutants encountered by the animal which in turn could be used as biomarkers for ecotoxicological studies and biomonitoring.

Complete mitogenome characterisation of the mud spiny lobster *Panulirus polyphagus*

The complete mitochondrial genome sequence of *P. polyphagus* collected from Mumbai was characterized using NGS technology (Illumina platform). The assembled mitogenome is 15680 bp, A+T rich and comprised of 13 protein-coding genes, 2 rRNA genes, 22 tRNA genes and a putative control region. The gene order is consistent with the pancrustacean ground pattern. The population structure study using molecular markers *viz*. COI and Control Region sequences is in progress

Table. F-Statistics and gene flow over all locations for each locus for *Lutjanus argentimaculatus*

Loci	F_{IS}	F_{IT}	F_{ST}	Nm
PRS275	0.080	0.150	0.076	3.029
LK31	0.050	0.059	0.010	25.511
90RTE	0.000	0.023	0.023	10.772
BST2.33	0.261	0.278	0.024	10.357
BST6.56	0.216	0.297	0.104	2.162
BST6.39	0.035	0.043	0.008	32.562
Lca20	-0.019	-0.005	0.014	17.344
Lca22	0.158	0.173	0.018	13.984
Lca27	0.075	0.080	0.005	46.108
Lru001	-0.002	0.014	0.016	15.063
Lru010	0.016	0.033	0.018	13.899
Lru013	0.019	0.028	0.009	26.41



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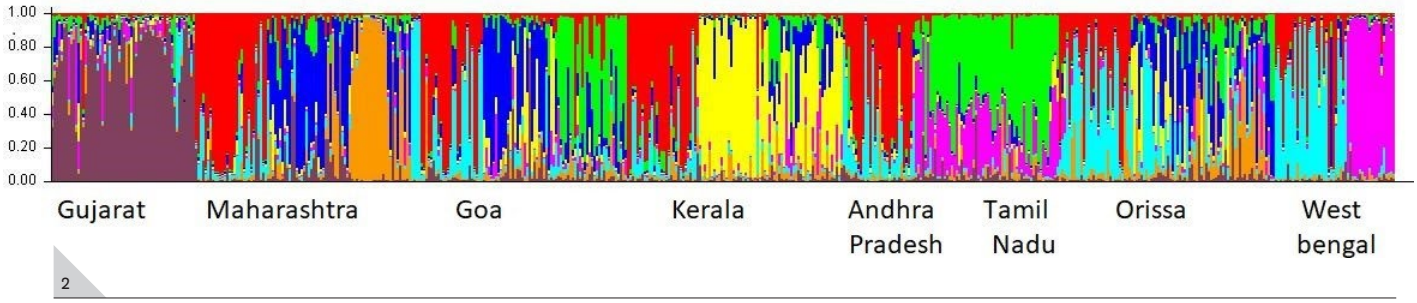
Genetic stock structure analysis of *Lutjanus argentimaculatus* using polymorphic microsatellite markers.

Genetic stock structure of *L. argentimaculatus* collected from Indian waters was investigated using 12 polymorphic microsatellite markers. A total of 384 individuals from six different geographic locations (Mumbai, Mangalore, Kochi, Mandapam, Vizag and Port Blair) were used for the study. Data generated from all the 12 loci was considered. The mean of observed number of alleles was found to be 29.5. The observed heterozygosities and expected heterozygosities were found to be 0.734 and 0.791 respectively. Pair wise F_{ST} values and AMOVA results indicated lack of stock structuring in *L. argentimaculatus.* Bar plot of structure analysis for microsatellite data also supported this finding. Bottleneck analysis using Wilcoxon test and Mode shift test hints a stable expanding population in Indian waters.



1. Principal Coordinate Analysis (PCoA) using 12 microsatellite loci for L. argentimaculatus
2. Bar plot of structure analysis using 12 microsatellite loci in *E. tetradactylum*

Population genetic structure of *Eleutheronema tetradactylum* using polymorphic microsatellite markers

Genetic stock structure of *E. tetradactylum* was studied using 12 polymorphic microsatellite markers by collecting a total of 510 samples from Veraval, Mumbai, Goa, Kochi, Mandapam, Vizag, Chilka and Digha. The total number of alleles per locus ranged from 17 (Pse 8) to 68 (Ptd 15) with the allele size of 100 to 436bp. The mean value of expected heterozygosity (He- 0.800) for each population was high compared to observed heterozygosity (Ho–0.664). Pair wise F_{ST} values and AMOVA results indicated lack of stock structuring in *E. tetradactylum*. Bar plot of structure analysis for microsatellite data also supported this finding. Bottleneck analysis indicated a stable expanding population in Indian waters.

Growth, and growth related gene expression in juvenile of Indian pompano *Trachinotus mookalee* fed with different feed

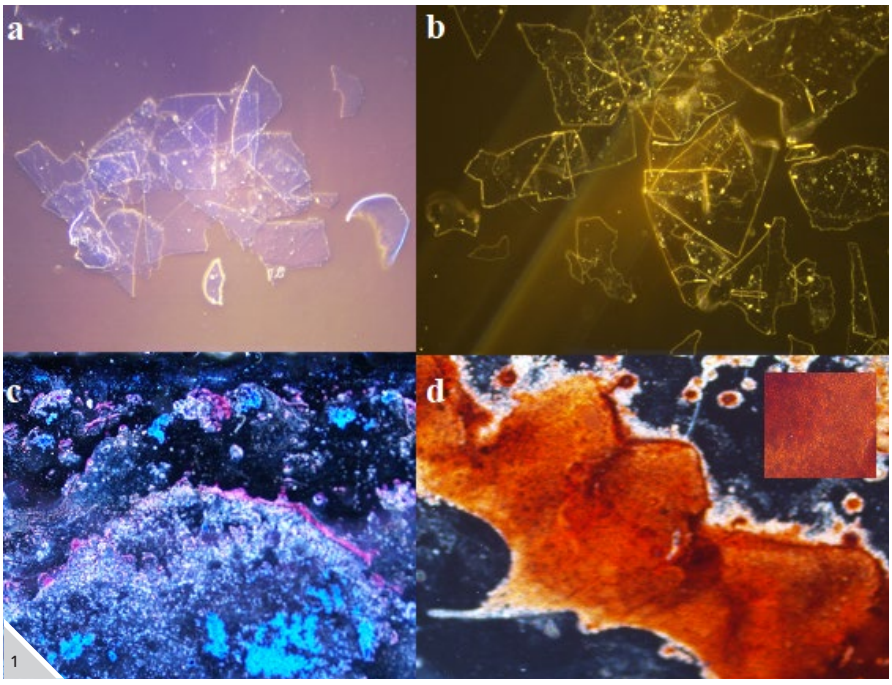
A feeding trail was conducted to determine the suitable feed with different protein and to observe the effect of different feed on growth, and changes in the expression of growth related genes such as growth hormone (GH) and Insulin like growth factor -I (IGF-I) for juvenile of Indian pompano (*Trachinotus mookalee*) in confined environment. Growth parameters (%WG: 651±11.43, SG: 3.36±0.025, FCR: 1:1.985) were significantly ($p<0.05$) high for juveniles fed with commercial pelleted feed of 45% CP. GHmRNA level in 45% commercial fed fish showed significantly higher expression rate. The study illustrated that *T. mookalee* juveniles fed with commercial diet containing 45% CP and 10% crude fat showed comparatively better growth performance and it may be considered as optimum feed for nursery rearing.

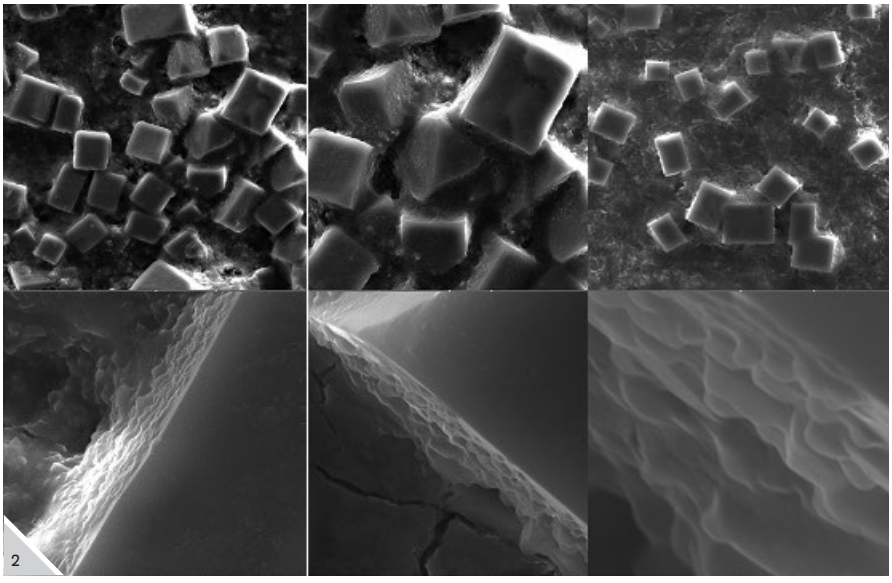
Biomineralization of mantle tissue from pearl producing molluscs

Numerous transparent and luminescent structures observed floating in the mantle cell cultures of *Pinctada fucata* were collected and analysed to reveal the genesis of nacre layer formation. Periodic acid and alizarin red staining proved the presence of polysaccharides and calcium carbonate ($CaCO_3$) crystals in these structures. FTIR analysis confirmed the presence of CH_2 & CH_3 of organic matrix by the peaks along 2919.18 cm^{-1} and 2850.34 cm^{-1} and CO_3 of aragonite by that along 1477.09 cm^{-1}. Aragonite tablet formation by $CaCO_3$ bricks sandwiched with organic matrix to form the lamellar nacre layer was clearly evident by Scanning Electron Microscopic (SEM) analysis

The ability of mantle tissue of *P. fucata* to induce lustre under *in vitro* condition on experimental beads and titanium plate (a non-$CaCO_3$ substrate) were analyzed. Typical aragonite coating on both surfaces were revealed by SEM. Deposition of $CaCO_3$ crystals was proved by Energy Dispersive X-ray Spectroscopy (EDS) and the micro-structural details

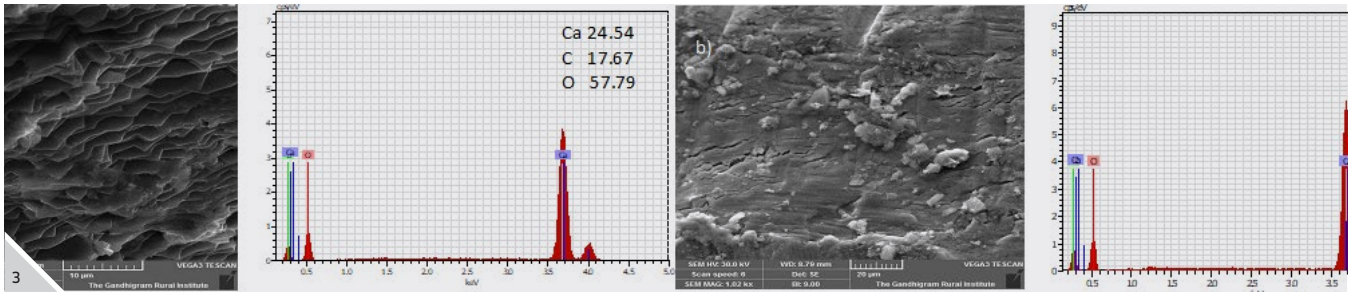
Genetics and Genomics





1. View of the floating structures in the mantle cell suspension of *P. fucata* under Phase contrast microscope, c) Periodic Acid-stained structures showing the presence of Mucopolysaccharide (Purple) and Acidic polysaccharide (Blue), d) Alzarin red stained structures revealing calcium carbonate crystals in the organic float (Brick Red structures)
2. Scanning Electron Microscopic images of the surface of floating structures in the mantle cell suspension of *P. fucata* at different magnifications showing bricks of calcium carbonate. Bottom. Side view of bricks at different magnifications showing lamellar aragonite formation
3. a) Lamellar nacre layers by the mantle cells of *P.fucata* revealed by SEM and CaCO3 deposition by EDS on shell bead b) Crystal deposition by SEM and CaCO3 deposition by EDS analysis on titanium plate
4. 2D and 3D AFM images showing the topography of nacre deposition by the mantle cells of *P. fucata*

Genetics and Genomics



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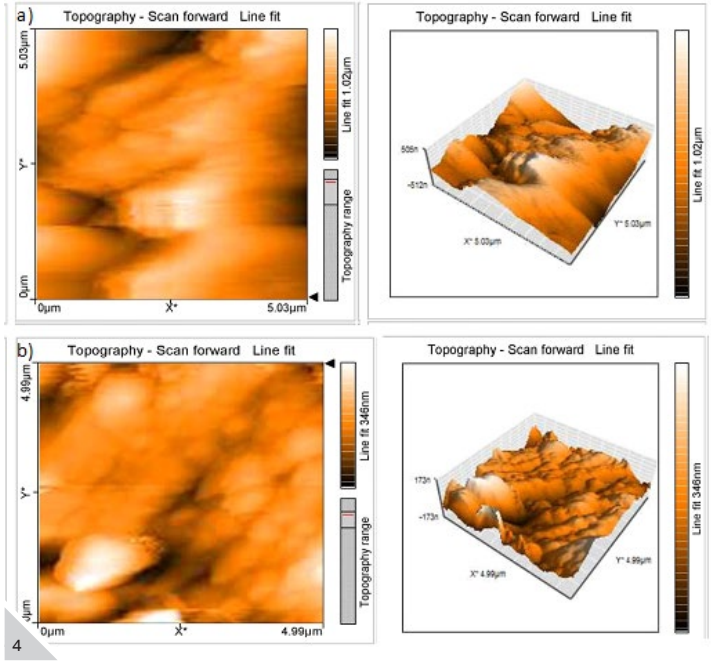

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of coating on the surface confirmed by Atomic Force Microscopy (AFM) for the first time. Further, deposition of nacre on titanium proves its potential application as a suitable biomaterial in dental and bone implants, due to its biocompatibility towards regeneration.

The major bioactive compounds were identified in the aqueous methanolic extract of whole body of *P. fucata* by GC-MS analysis, and included L-Alanine, 2-piperdinone, 1-methyl, 2-heptanol, 6-amino-2-methyl and 3-undecene.

Incubation of bead nuclei in a semi-solid agar substrate with granulated epithelial cells of *Pinctada margaritifera* in culture medium induced a thick, nacreous layer formation over the beads. After 60 days, several of the nacre coated beads exhibited a lustrous hue on part of the bead surface similar to that seen on pearls; this is the first time that formation of a pearly nacreous material on a bead surface was achieved under *in vitro* conditions using cultured mantle epithelial cells from *P. margaritifera.* Analysis of the lustrous surface and its cross-section by SEM and EDAX showed a good brick and mortar arrangement of aragonite tablets and increased concentration of calcium.

Use of supplements such as bovine insulin, Epidermal Growth Factor (EGF), catalase and calcium chloride significantly increased viability of cells in culture, after 10 and 20 days. Calcium chloride ($CaCl_2$) and bovine insulin (BI) considerably improved proliferation and viability of cultured cells.

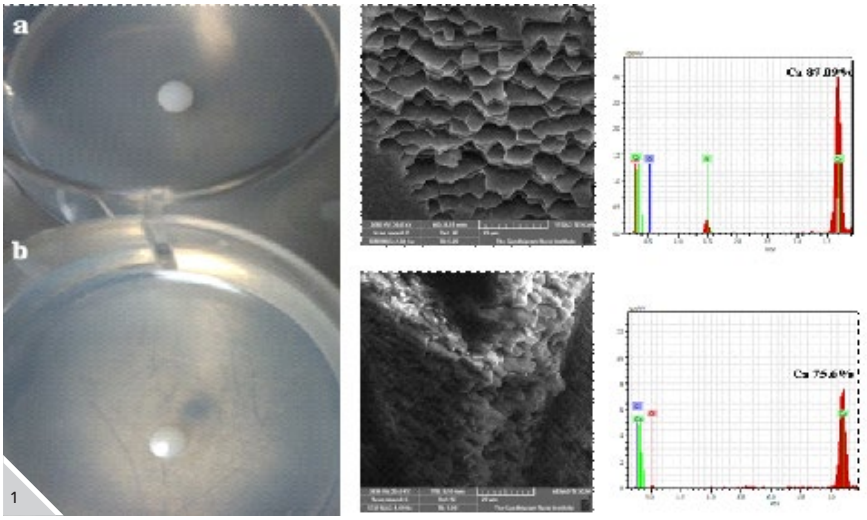
A protocol established to cryopreserve cultured granulated epithelial cells of

Genetics and Genomics

P. margaritifera using 10% concentrations of both glycerol and DMSO provided optimum cryoprotection, with 90-95% viability. Cryopreserved cells used to induce nacre deposition on nuclear beads showed good proliferation and growth.

The partial cDNA sequence of nacrein gene was analyzed, annotated for functional regions and submitted to NCBI database (GenBank accession no: MK531554).

Derivation and characterization of embryonic stem (ES) cell lines from



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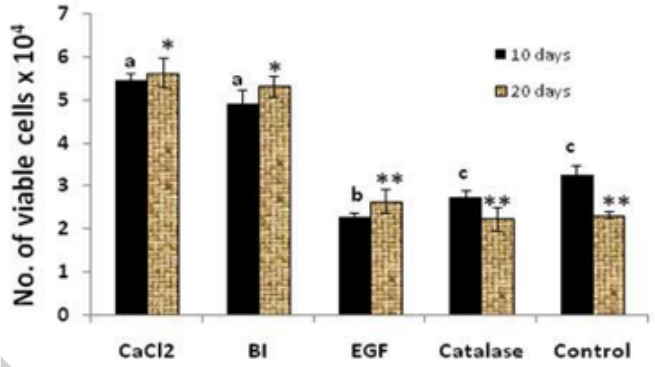

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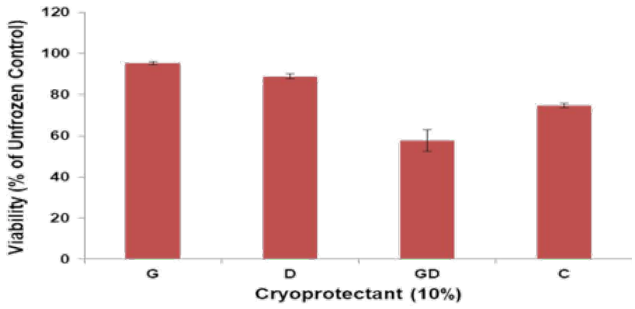

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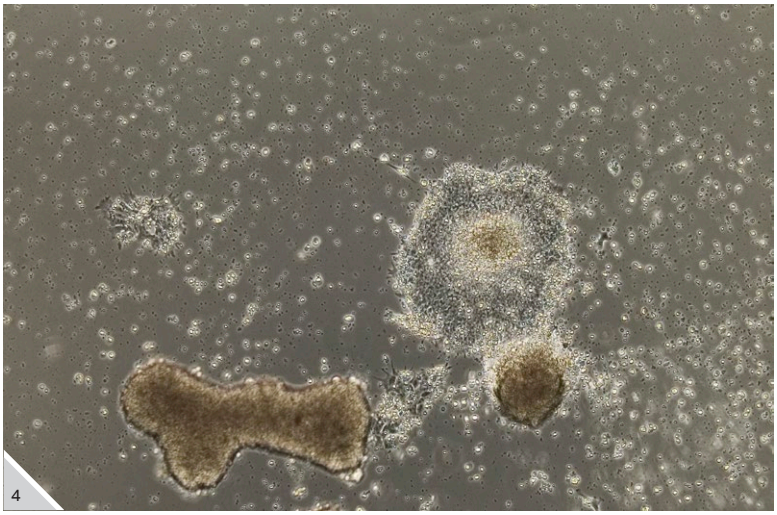
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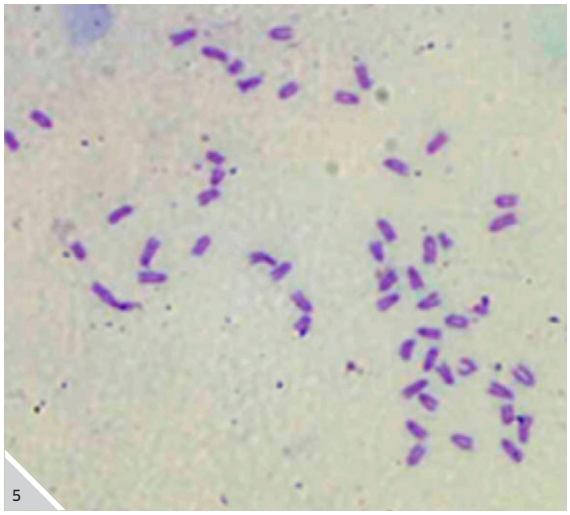
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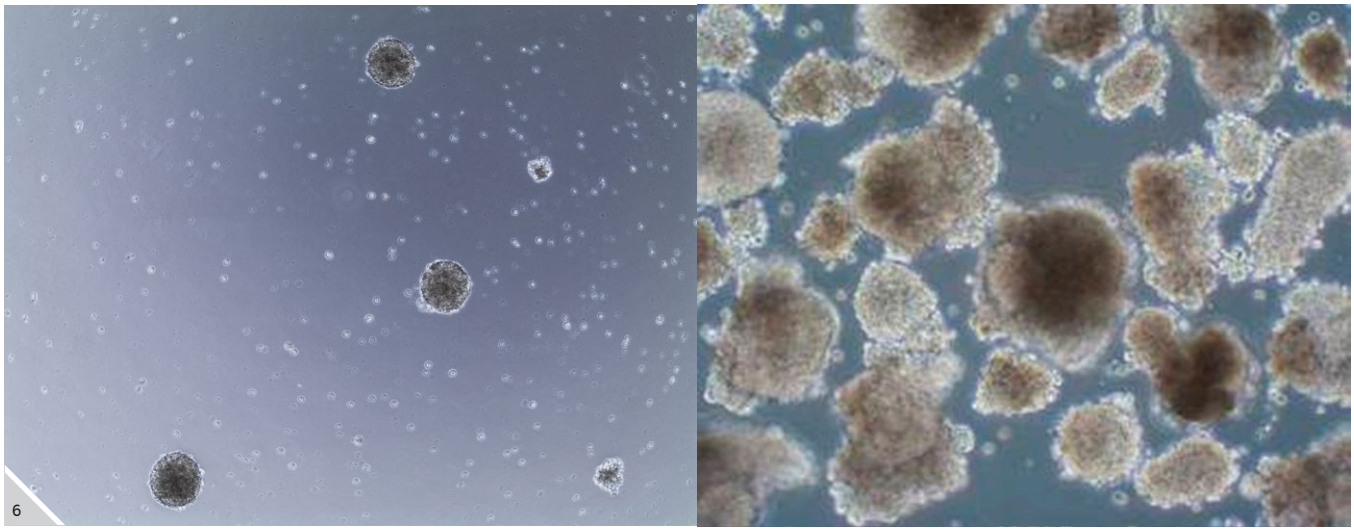


1. Lustre formation on *in vitro* nacre coated beads incubated in semi-solid substrate with cultured granulated mantle epithelial cells of the black-lip pearl oyster, *P. margaritifera* observed by camera; a) uncoated control bead; b) experimental bead showing lustrous hue (indicated by arrow). Right: Scanning electron microscope image and X-ray spectrum of, Top: lustrous surface of *in-vitro* nacre coated bead; Bottom: cross-section of lustrous region of bead.
2. Effect of cell supplements on viability of cultured mantle epithelial cells of the black-lip pearl oyster, *P. margaritifera*
3. Cryoprotective effects of 10% glycerol (G), dimethyl sulfoxide (D) and a mixture of the two cryoprotectants (GD) on viability of cultured mantle epithelial cells of the black-lip pearl oyster, *P. margaritifera* after storage at low temperature for 14 days; C-Frozen control
4. ES cell colonies, post-subculture
5. Metaphase spread from *P. biaculeatus* ES cells
6. ES cells–Embryoid body formation in Ultra-Low Adherence Dish

the marine ornamental maroon clown fish *Premnas biaculeatus* and induced pluripotent stem (iPS) cell lines from the humpback grouper, *Cromileptes altivelis*

Embryonic stem cell cultures (ESCs)

Embryonic stem (ES) cell cultures derived were characterized by karyotyping. *In vitro* differentiation (embryoid body formation) was attempted by suspension culture in ultra-low adherence dish.

Environmental DNA metabarcoding-based estimation of marine stocks (MBT/DNA/37)

Water samples were collected from 10 different stations in Kavaratti Island along the coral reefs. Water was filtered using 0.45µm vacuum filter. Environmental DNA (eDNA) was extracted from one sample, PCR-amplified and performed Next Gen Sequencing (NGS). Preliminary analysis has indicated presence of a total of 302 species; the occurrences of many of which are confirmed based on video transect data taken from the same region. At the same time sequences of many fish species not found in the footage were also present in the NGS data. Acanthuridae and Pomacentridae were the most abundant families, together constituting almost 60% of the sample. There was around 24% contamination from laboratory DNAs; of the species which are unlikely to be present in the target samples. Detailed analysis of the data along with efforts to trouble shoot lab contamination are progressing.

Fish Nutrition

Research Project: MBT/NTM/24

Feed commercialization

Commercial production trials of freshwater ornamental fish feed, '*Varsha*' developed by CMFRI in the ICAR-Outreach Activity on fish feeds were completed. Five formulations standardized in the laboratory scale extruder were produced in batches of 500 kg and the product yield and problems were documented. Only one out of the five formulations standardized in the lab scale extruder yielded the desired quality and quantity. The remaining four formulations have to be reworked. The standardized

1

1. Pompano reared on fishmeal free feed
2. **Finished product packs of Varsha**

formulation which yielded the desired product quality planned to be produced on a commercial scale for sale in the open market by M/s Taiyo Feed Mills Pvt. Ltd. Chennai, the commercial partner.

2

Fish meal replacement

Fishmeal (FM) replacement with cottonseed meal (CSM) in the diet of snubnose pompano on growth and immunity was studied. This study revealed that fishmeal can be completely replaced with cottonseed meal without any adverse effect on growth and immunity of snubnose pompano.

An attempt was made for the production of insect meal (greenbottle fly pupae meal–GFPM) from tuna waste and the nutritive profile of GFPM indicated the presence of EPA and DHA, in a scenario where, insect meals are generally

Proximate composition and fatty acid profile of green bottle fly pupae meal

Proximate composition	**%**
Moisture	4.3
Crude protein	49.65
Crude fibre	8.38
Ether extract	26.77-29.89
Total ash	4.46
Gross energy	6.098 Kcal/g
Fatty acid profile	
Myristic acid	4.03
Palmitic acid	29.55
Stearic acid	3.85
Oleic acid	24.34
Linolenic acid	0.79
Linoleic acid	0.41
Arachidic acid	1.83
Behenic acid	4.04
EPA	8.75
DHA	10.64
Palmitoleic acid	11.72

reported to be deficient in highly unsaturated fatty acids (HUFA).

Research on Black Soldier Fly (BSF) larvae as a fish feed ingredient continued by upscaling of production system- a new unit was designed for increasing the production of BSF larvae, which can handle 30 kg of organic waste per production cycle (25-30 days). An assembled system for washing and collection of BSF larvae, since larvae are superior to pupae with less content of chitin) was also developed. Dry BSF larvae were also profiled for their fatty acid content.

1. Set up units for egg collection, incubation and hatching
2. *Heterochlamydomonas lobat*

Micro algae

New algae with high red pigment was isolated from Gulf of Mannar by serial dilution and agar plating methods. It is identified as *Heterochlamydomonas lobata* by gene sequencing comparing with morphological characters.

Gene sequencing was done for the new microalgae with high red pigment and the identification comparing with morphological characters is in progress.

Lobster nutrition

Three pellet feeds having crude protein content of 47-52% and crude lipid content of 11-16% were formulated using fishmeal, squid meal and soybean meal as the main source of protein, respectively in the three feeds. Other protein sources used included *Acetes* meal, wheat flour and gelatin. A 150-day experimental trial was carried out to compare the effects of these three formulated pellet diets on growth and survival of juvenile spiny lobster, *Panulirus homarus* having an initial average body weight of 85.2±5 g and carapace length (CL) of 45±0.8 mm, using fresh clam meat as the control

Fatty acid profile of dried BSF larvae

Fatty acid	%
Myristic acid	13.76
Palmitic acid	24.49
Stearic acid	2.79
Oleic acid	20.55
Linoleic acid	29.61
Linolenic acid	0.60
Arachidic acid	0.30
Behenic acid	0.70
Eicosapentaenoic acid	1.86
Docosahexaenoic acid	0.60
Palmotoleic acid	4.43
Others	0.25

Fish Nutrition

Ingredient composition of formulated feeds

Ingredients	Fish meal based feed (g/100 g)	Squid meal feed (g/100 g)	Soybean meal based feed (g/100 g)
Fish meal	40	14	10
Squid meal	10	30	10
Acetes meal	10	10	10
Soybean meal	10	10	47
Gelatin	2	2	2
Cod Oil	4	5	5
Lecithin	3	3	3
Vit-Min mix	1	1	1
Cholesterol	1	1	1
Wheat flour	17	17	9
CMC	1	1	1
Cellulose/Earth	1	6	1
TOTAL	100	100	100

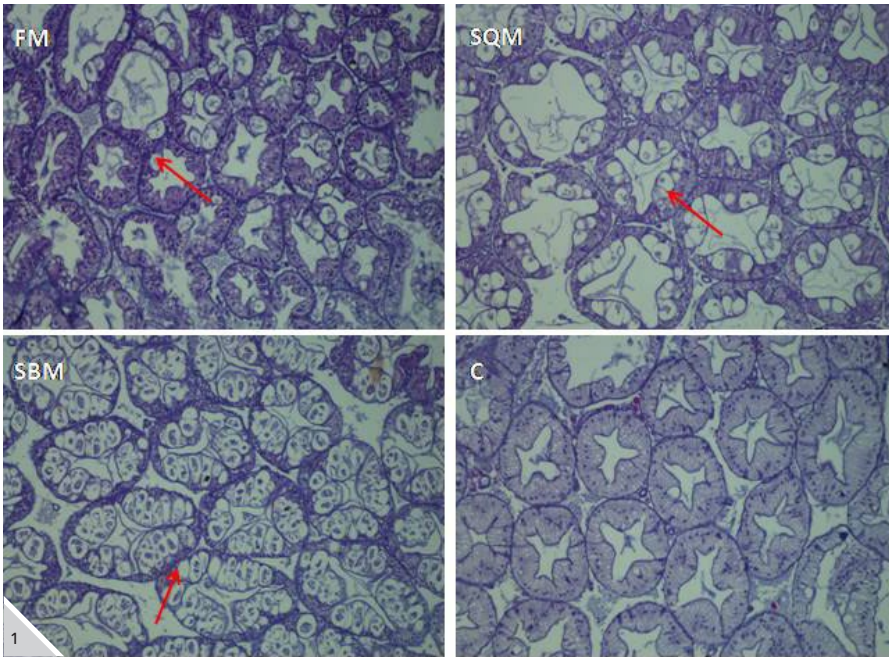
Proximate composition (%) and energy content of the formulated feeds

	Moisture	Protein	Fat	Carbohydrate	Ash	Energy kcal/100 g
Fishmeal based feed	6.4	52.3	11.3	18.2	11.8	384
Squid meal based feed	6.6	49.6	12.8	20	11	394
Soy meal based feed	8.8	47.7	16.8	18.5	8.2	416

Survival and growth of lobsters

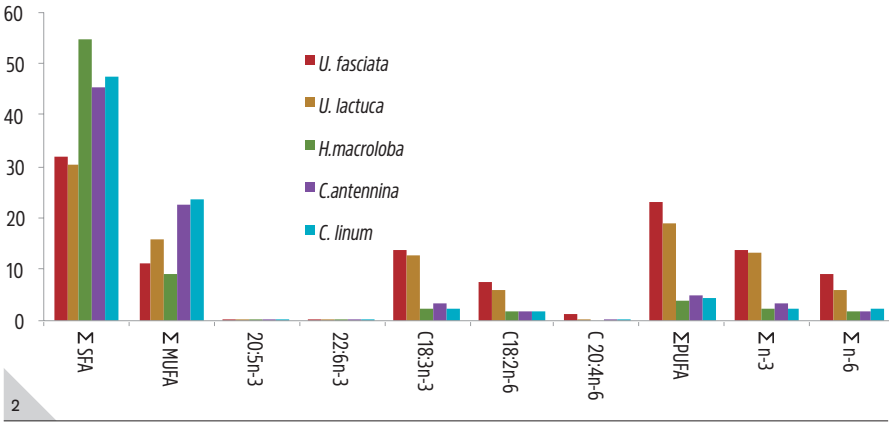
	Survival (%)	Specific growth rate	Hepato-somatic index
Fish meal feed fed group	95	0.19	4.0
Squid meal feed fed group	100	0.21	4.0
Soybean meal feed fed group	95	0.01	3.8
Clam fed group	95	0.30	4.2

diet. Five animals were stocked per experimental group in each compartment of 700 L rectangular FRP tanks divided into two compartments using nylon mesh, filled with filtered seawater (32%), and equipped with aeration. The experiment was conducted in duplicate. Feeding was carried out 3 times a day at 1.5-2.0% of the body weight. Lobsters fed on live clam (*Meretrix* sp.) were used as Control. Growth rates in animals fed on fish meal based and squid meal based diets were better with average weight gains of 0.2 g/day in both groups, and not much lower to that seen in the Control group (0.3 g/day). Animals fed on soybean meal based diets however showed very poor growth, signifying poor assimilation. Lobsters fed with clams had a slightly higher hepatosomatic index (HSI) compared with lobsters fed with pellets; lobsters fed on soybean meal diet had the lowest



1. Histological examination of hepatopancreas of lobsters fed on fish meal based (FM), squid meal based (SQM) and soybean meal based (SBM) pellet diets and clam (C). Arrows indicate B-cells.
2. Fatty acid profiles of chlorophytan seaweeds.
3 &4. Macormineral profile
5. Amino acid profile

HSI. Histological examination of the hepatopancreas revealed that the B-cells were significantly larger and more in number in the hepatopancreas of lobsters fed pellet feeds, and soybeanpellets in particular. Higher B-cells area indicates a greater digestive effort by lobsters to digest pellet feed. The ready acceptance and the fact that the fish and squid based pellet feeds gave reasonable growth rates; however, imply that the feeds were digested at a level similar to that of the natural feed. This denotes an effective capacity of lobsters to digest artificial feeds. Improving the dissolution of dietary ingredients in the foregut could help improve the overall digestibility and performance of formulated diets for spiny lobsters.

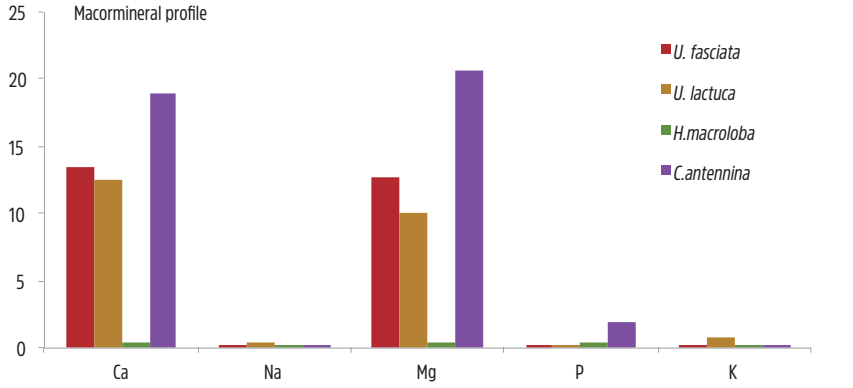


Nutritional biochemistry

Nutritional evaluation of the commonly available tropical Chlorophytan seaweeds

The present study highlighted the nutritionally important constituents present in tropical green seaweeds and that could be a potential health food. The n-3/n-6 ratio of *Ulva lactuca* (~2.14) showed the consumption of this species of seaweed would be ideal for health promoting benefits. EPA and DHA were in lower levels in all the seaweeds and did not exceed more than 3-4% as reported earlier. *U. fasciata* displayed a high linolenic acid C18:3n-3 (13.72%) and C18:2n-6 linoleic acid (7.75%) content when compared to the other studied species. *Chaetoporpha linum* otherwise known as the spaghetti algae demonstrated large proportion of macro minerals, such as Ca, Mg, and P nutrient

Fish Nutrition



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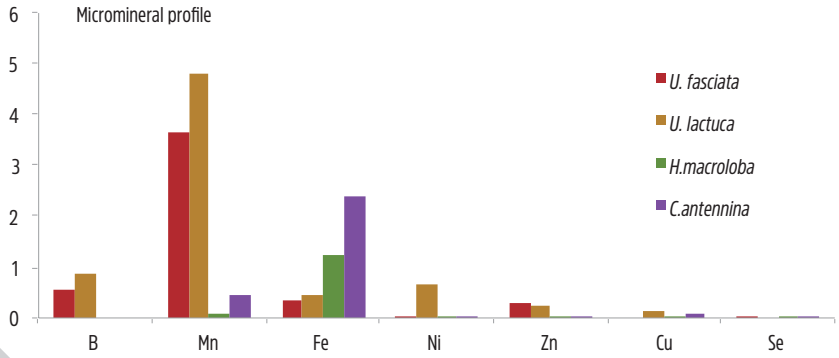

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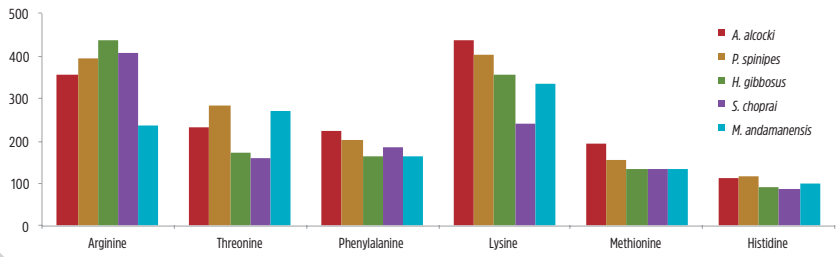
- The n-3/n-6 ratio of *U. lactuca* (~2.14) showed that the consumption of this species of seaweed would be ideal for health promoting benefits.
- EPA and DHA were in lower levels in all the seaweeds and did not exceed more than 3-4%. *U. fasciata* displayed a high linolenic acid C18:3n-3 (13.72%) and C18:2n-6 linoleic acid (7.75%) content when compared to the other studied species.

content, and could be palatable if proper processing measures are incorporated for human consumption. It is suggested that the seaweeds taken in the current study from the family *Ulvaceae* could be a potential source for dietetic products and food supplements and could be a better food source than *Halimeda*. *C. linum* recorded more prominent Ca content along with K contents. Seaweeds are known to contain high levels of K when compared to terrestrial plants and in combination with other nutrients helps to control blood pressure and other heart related risks. The magnesium level was in the order *C. linum* > *C. antennina* > *U. fasciata* > *U. lactuca* > *Halimeda macroloba*. This study revealed that green seaweeds could be a source of magnesium promoting health benefits.

Considering the increasing demand of



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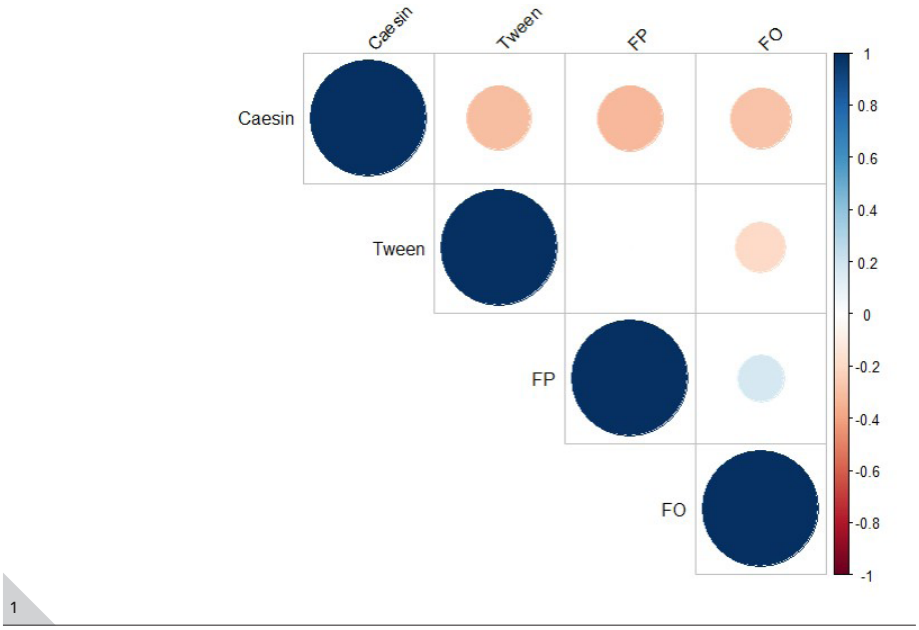
- The studied shrimp species possesed a good amount of phenylalanine with higher amount in *A. alcocki* (222.92mg/100g) followed by *P. spinipes* (200.83 mg/100g) and others.
- *A. alcocki* possessed higher content of other essential amino acids lysine, methionine, leucine, isoleucine and threonine followed by *P. spinipes*.
- The ratio of essential amino acids (∑EAA) to non-essential amino acids (∑NEAA) ranged between 0.78 to 0.84, which is a good ratio.

food for human consumption and other purposes it is necessary to identify non conventional resources having potent nutritional benefits. In this context seaweeds plays a major role as it contain versatile biochemical constituents. Both the *Ulva* species such as *U. fasciata* and *U. lactuca* could be used as functional ingredients for the development of food supplements and also as alternative source of human and animal feed.

Comparison of biochemical composition analyses of deep sea shrimps

Shrimp is a good source of protein and balanced amino acids, making it a healthy food choice for consumers. Amino acid content of five shrimp species *Aristeus alcocki*, *Heterocarpus gibbosus*, *Parapenopsis spinipes*, *Solonocera choprai* and *Metapenaeopsis andamanensis* were compared. The essential to non-essential amino acid ratio of the five species ranged between 0.78 to 0.84. The total aromatic amino acids (∑ArAA) were recorded to be higher in *A. alcocki* (344.4 mg/100g) when compared with other shrimps. The total sulphur containing amino acids also showed higher values in *A. alcocki* (269.9 mg/100g). Aspartic acid was found to be higher in *A. alcocki* (502.33mg/100g) followed by *P. spinipes* (422.4 mg/100g) followed by *H. gibbosus* 362.9 mg/100g) followed by *M. andamanensis* (348.22 mg/100g) and *S. choprai* (286.53 mg/100g). *P. spinipes* contained higher histidine content (116.19 mg/100g) followed by *A. alcocki* (114.84mg/100g) followed by *M. andamanensis* (100.77mg/100g) followed by *H. gibbosus* (92.48 mg/100g) and *S. choprai* (85.85 mg/100g). Arginine was found higher in *H. gibbosus* (438.62 mg/100g) followed by *S. choprai* (407.54 mg/100g) followed by *P. spinipes* (393.94 mg/100g) followed by *A. alcocki* (356.42 mg/100g) and least in *M. andamanensis* (236.51 mg/100g).



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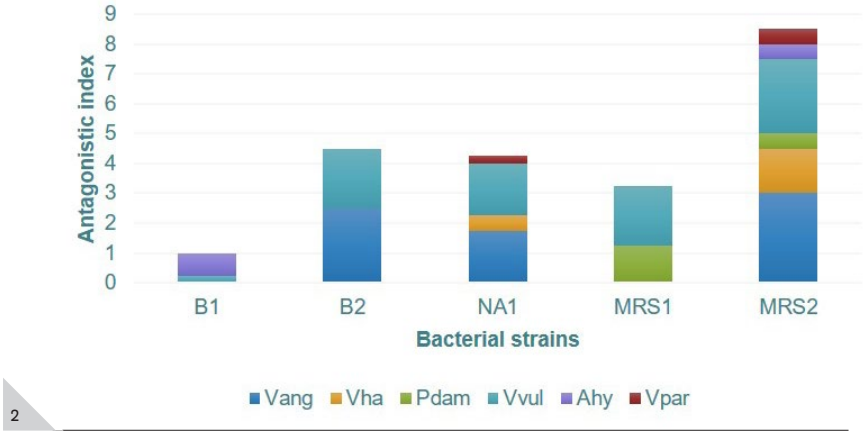
Development a fish waste degrading bacterial consortia

Substrate specific media in microbial screening assays for fish waste management

As selection of protease and lipase producing microbes is a major criterion for formulating a fish waste degrading bacterial consortia, the prime attention was given to reconfirm the significance of substrate specific media in microbial screening assays for fish waste management. In the present scenario, most researchers use casein embedded media for selecting protease strain and Tween 80 for lipid degrading bacteria in microbial screening assays for fish waste management. In order to address the

1. A cross-correlation analysis showing spearman's correlation between routine and substrate specific protein specific media
   Caesin: Caesin media; Tween: Tween 80; FO: Fish Oil media; FP: Fish protein media
2. Antagonistic index of different bacteria isolated from *P. viridis (Vang: Vibrio anguillarum; Vha: Vibrio harveyi; Pdam: Photobacterium damsellae; Vvul: Vibrio vulnificus; Ahy: Aeromonas hydrophila; Vpar: Vibrio parahemolyticus)*
3. Antagonistic potential of bacteria isolated from different tissues of *Perna viridis*

Fish Nutrition



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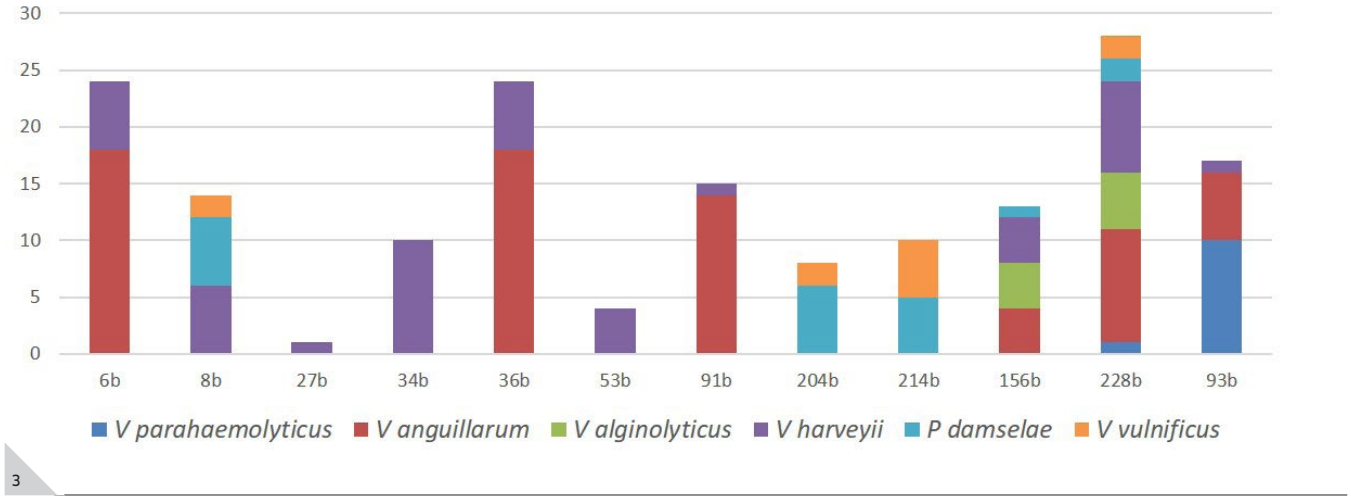

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discrepancy in research papers regarding screening media for microbes in waste management, a study was conducted to evaluate whether there is any difference in activities between routine and substrate-specific media. In present investigation, we evaluated 62 pure microbes for protease production as well as oil degradation using two sets of media, namely casein, fish protein (FP), Tween 80, Fish oil (FO) and embedded media and clearance zone were measured. Among 62 isolates, 66% and 25% isolates gave positive results in fish protein and casein media respectively. Similarly, 32% and 14% isolates gave positive results for Tween 80 and fish oil media respectively. Diameter of zone of clearance varied from 0.1–2.1 cm in casein media and 0.4-1.2 cm in fish protein media. Likewise, diameter of clear zones varied from 0.1–2.9 cm in Tween80 media and 0.2-1.14 cm in fish oil media.

Statistical analysis was done to find out the significant difference in each set of

substrate specific media used. A cross-correlation analysis using spearman rank correlation between zone diameters with respect to all media used in the study is also carried out (SPSS version 16). Results showed that there is no statistically significant correlation between these two set of substrate specific media used ($P > 0.05$). Further, there is statistically significant difference in hydrolytic activity between casein embedded media and fish protein embedded media ($p=0.032$) and between Tween 80 embedded media and fish oil embedded media ($p=0.000$) was also noted. Supplementary polyphasic taxonomic approach showed that casein and fish protein hydrolyzing microbes belong to different bacteria. All these results point to the need for substrate specific media for screening studies.

Development and validation of a microtitre plate based methodology for screening of microbes having sulphur oxidizing potential and characterisation of Nitrite-Oxidizing Bacteria and Ammonia-Oxidising bacteria

To assist the routine screening for different beneficial microbes relevant for formulating a fish-waste degrading consortia, different analytical methodologies have been developed with modifications from standard protocols. Consequently, a microtitre plate based methodology was developed for the screening of microbes having sulphur oxidizing potential. The assay was based on the principle of barium sulphate formation with a detection limit of 0.0045 mg/ml sulphate and a range of linearity as 0-1.17mg/ml sulphate concentration.

Further, to compare and scrutinize the degradation efficiency of the fish-waste degrading consortia, two reference strains of Nitrite-Oxidizing Bacteria (NCIM5076) and Ammonia-Oxidising bacteria (NCIM5078) were characterized and their pure cultures were preserved as glycerol stocks; with view to be used as reference strains for formulating fish waste degrading bacterial consortia. For this, media for isolation of Nitrite-Oxidizing Bacteria (NOB) and Ammonia-Oxidising bacteria (AOB) was also standardized individually and the specific-microtiter plate based analytical methodologies were developed for screening the activity of Nitrite-Oxidizing Bacteria (NOB) and

1. Sieve shaker with sieve assembly

Ammonia-Oxidising bacteria (AOB) respectively.

Screening for probiotic strains which have potential applications in fish nutrition

Bacteria isolated from different sources were screened for identifying suitable candidate species with a view to develop a potential probiotic strain. In this regard, a technology evaluation of a novel base formulation for bio-floc was carried out with a view to screen potential probiotic strains. In the study, 21 unique bacterial colonies were isolated from a base formulation for bio-floc, using selective and non- selective media. Further, bacterial identification was carried out using polyphasic taxonomical approach and the enzymatic and antagonistic properties were checked for the same isolates. *In vitro* screening for antagonistic activity against aquatic pathogens showed that MRS2 is a potential probiotic strain with antagonistic activity against almost all aquatic pathogens studied. The major bacteria identified include: *Rautella sp., Bacillus sp.* and *Weisella confuse* (MRS2). Further, bacteria isolated from different tissues of *P. viridis* were also screened for their antagonistic potential against aquatic pathogens. The antagonistic activity of identified isolates was assessed using spot inoculation on agar method.

In the following step, to screen their secondary metabolite biosynthesis, different biosynthetic genes were selected; namely, Polyketide synthase (PKSs) and non-ribosomal peptide synthetase (NRPSs). These are large multimodular enzymes involved in biosynthesis of polyketide and peptide secondary metabolites produced by microorganisms, such as bacteria and fungi. In present study, those marine bacteria showing antagonistic potential against aquatic pathogens were also screened for PKS I and NRPS genes which could be accountable for bioactive secondary metabolites biosynthesis.

As an initial step, PCR-based assay targeting Non-ribosomal peptide synthetases (NRPS) and Modular polyketide synthases (PKS-I) in those isolates showing antagonistic potential against aquatic pathogens in the study, were optimized using template DNA from respective isolates. The amplicon size for NRPS, PKS obtained using specific primer is ~1000bp, ~600-700bp respectively; based on the bacterial species used.

In-house fabrication of an electrical orbital sieve shaker assembly for use in experimental feed mill

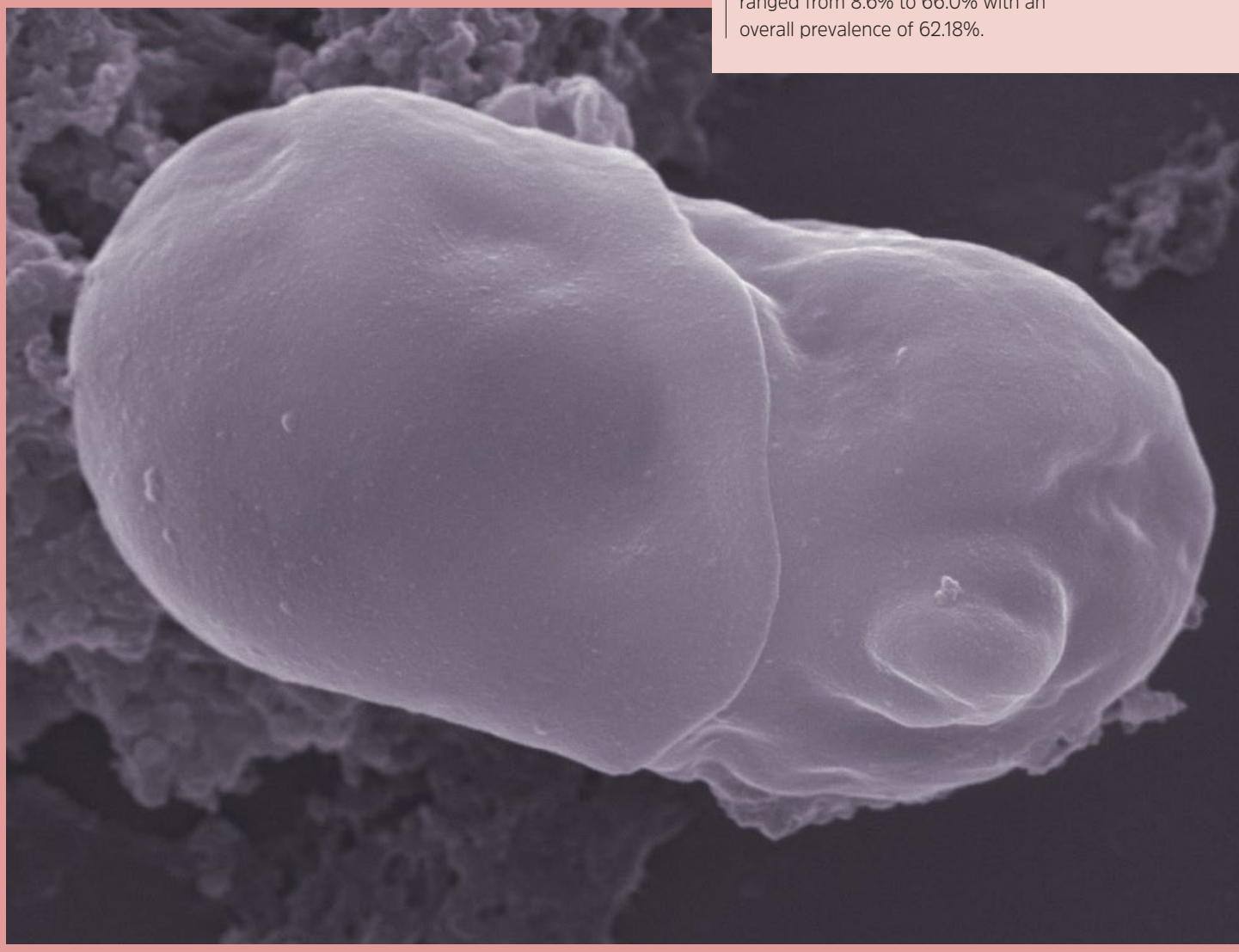
Owing to the increasing demand for fish feeds, an economical model of sieve shaker was assembled in house. A significant reduction (almost one third) in feed processing time, man power and loss of feed as dust was witnessed. Different sizes of feed (0.25, 0.5, 0.75, 1.0, 1.5, 2.0 and 3.0 mm) can be obtained simultaneously. The total cost of assembling of the unit was less than 1/10th as that of commercial models available with similar specifications.

Fish Health and Marine Bioprospecting

Research project: MBT/HLT/23

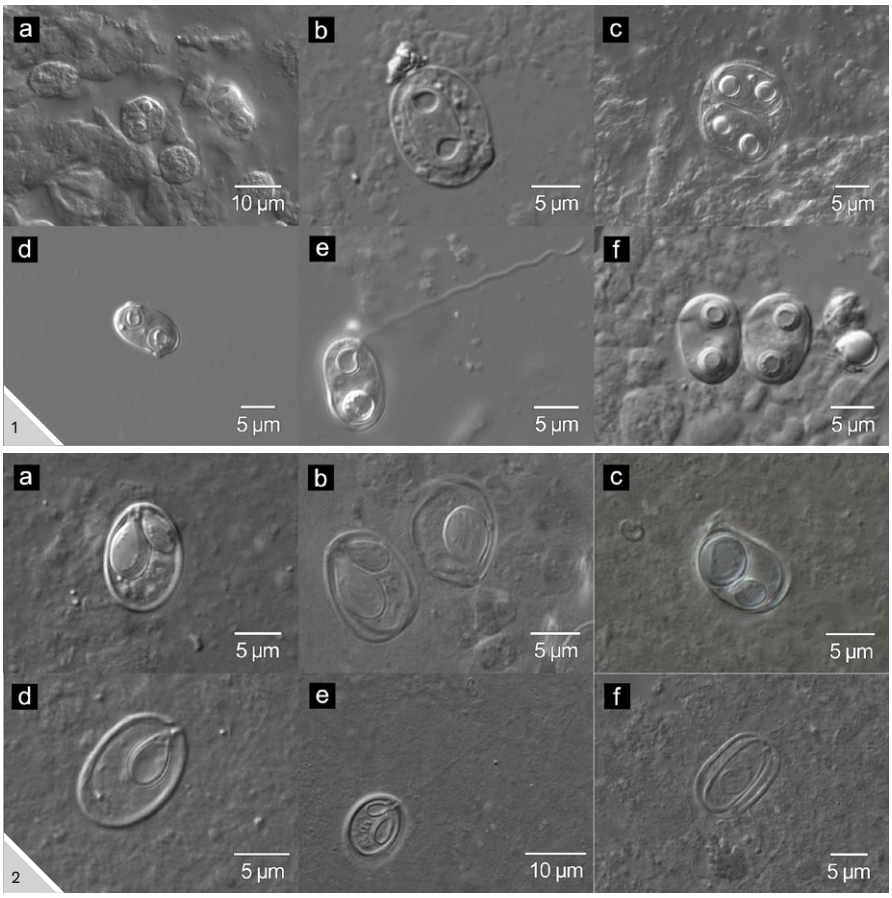
Disease investigations in finfishes

Myxosporean infections in fishes: Infections with myxosporeans were reported from 448 of 732 food fishes screened. Myxosporeans belonging to five genera namely, *Ceratomyxa*, *Ellipsomyxa*, *Zschokkella*, *Myxobolus* and *Sphaerospora* were recovered. Prevalence of infection ranged from 2.0% to 100% while the overall prevalence stood at 61.2%. In marine ornamentals, the prevalence ranged from 8.6% to 66.0% with an overall prevalence of 62.18%.



Fish Health and Marine Bioprospecting

1. Spore of *Ellipsomyxa ariusi* n. sp.
2. Spores and developmental stages of *Ellipsomyxa ariusi* n. sp.
3. Spores and developmental stages of *Myxobolus chanosi* n. sp.



One of the myxosporeans belonging to the genus *Ellipsomyxa* and infecting the gall bladder of the cat fish, *Arius arius* was significantly different from all previously described species. Morphology and morphometry of spores and developmental stages were studied in detail. Molecular and phylogenetic analyses were also carried out. The studies revealed it to be a new species under the genus *Ellipsomyxa* and has been reported as a new species, *Ellipsomyxa ariusi* n. sp. A second species of myxosporean infecting the kidney of farmed *Chanos chanos* from Alappuzha was also studied in detail. Morphology, morphometry and molecular analysis indicated it to be a new species under the genus *Myxobolus* and has been reported as a new species, *Myxobolus chanosi* n. sp.

A new species of acanthocephalan parasite, infecting *Scatophagus argus* has been identified and described. Morphological and morphometric analysis using light and Scanning Electron Microscopy, and molecular and phylogenetic analyses indicated it to be distinct from previously described species and hence considered new and named *Filisoma argusi* n. sp. Histopathological alterations in intestinal tissues were also studied.

Infection with *Amyloodinium ocellatum* was reported from fingerlings and

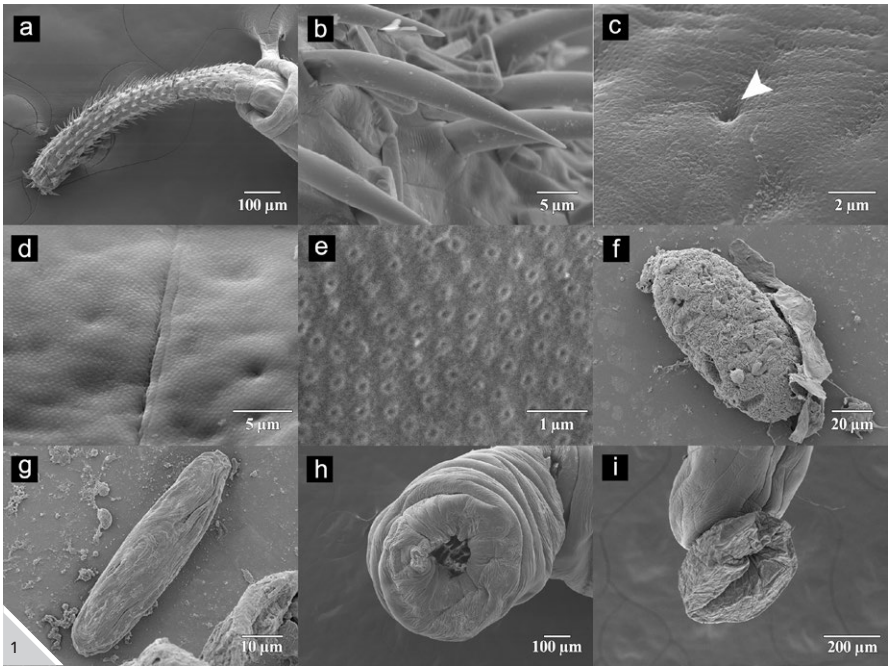
brooders of pompano at Vizhinjam, Mandapam and Karwar. *A. ocellatum* was also reported from *Amphiprion ocellaris* and *Chromis viridis* at Karwar.

Infestation with *Trichodina* spp. was reported in pompano fingerlings at Kakinada and Karwar, and cobia fingerlings at Mandapam. Infestations with the gill flukes, *Dactylogyrus* sp. and *Diplectanum* sp. were reported from *Epinephelus coioides* and *Lates calcarifer* respectively at Karwar. Infestation with *Cymathoa* was recorded from giant trevally at Chennai. Infestation with *Argulus quadristriatus* was observed in *L. calcarifer* at Karwar and forms the first report of this parasite infection in cage culture ecosystem. Infestation with *Lernanthropus* sp. was reported from hatchery-maintained pompano at Karwar. Wild *Lutjanus argentimaculatus* collected from Karwar were infected with the zoonotic parasite, *Anisakis* sp. A comparative study of parasites infecting cage farmed, nursery reared and wild marine fish at Karwar revealed that composition of parasite fauna as well as their prevalence varied with different culture systems as well as seasons. *A. ocellatum, Trichodina* sp. and *Dactylogyrus* sp. showed high Parasite Frequency Index.

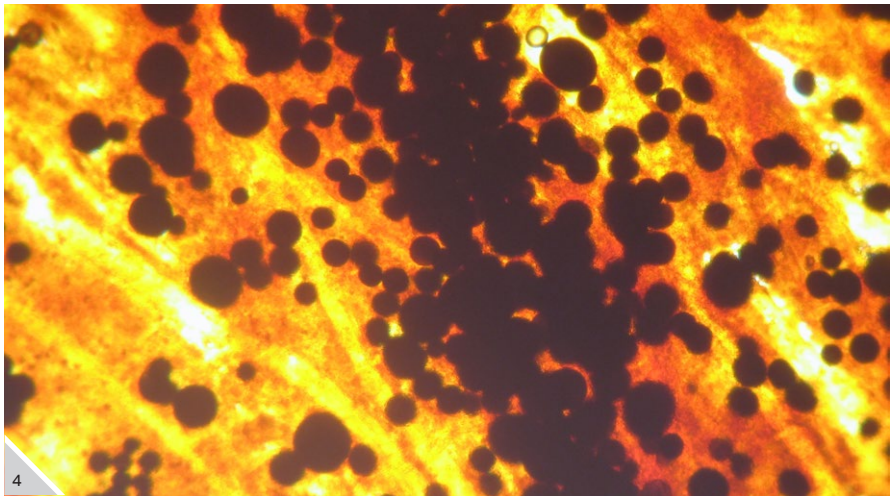
Disease investigations in lobsters: Infestation with *Lepas* sp. and egg predator worms were observed on berried sand lobsters at Chennai.

Disease investigations in bivalves: Infections with the OIE listed pathogen, *Perkinsus olseni* was observed in most of the bivalve samples examined. Infections with *P. beihaiensis* were also recorded.

Morphologic changes in the digestive gland of marine bivalves were characterized for developing indicators



Fish Health and Marine Bioprospecting



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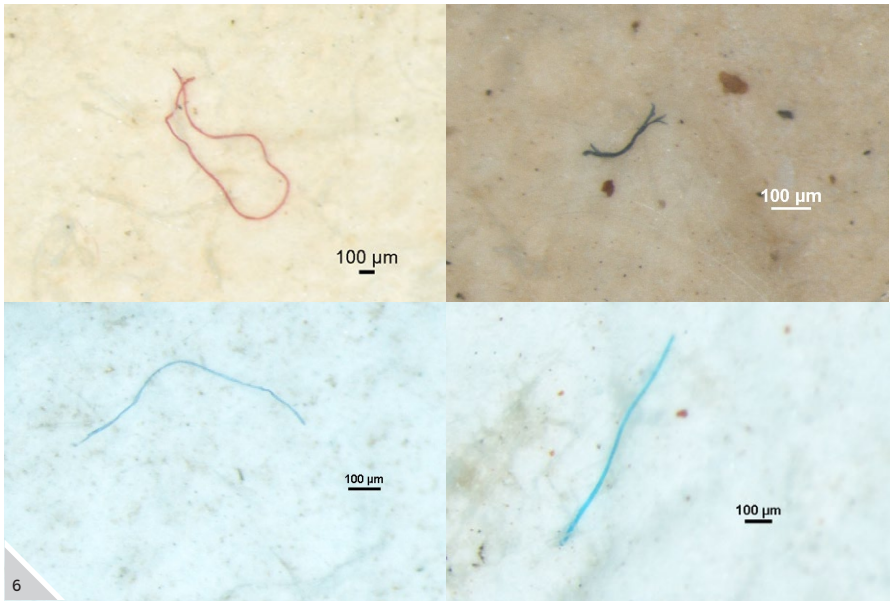

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1. *Filisoma argusi* n. sp. infecting *S. agrus*
2. Carcinonemertean worm infection in lobster
3. *Lepas* sp. infestation in lobster brooder
4. *Perkinsus* infection in bivalve tissues
5. Occurrence of microplastics in the digestive gland of marine bivalves
6. Bacterial skin lesions in pompano

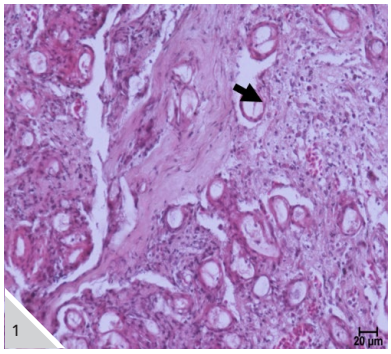
of environmental pollution. Occurrence of microplastics in the digestive gland and gills, and nuclear abnormalities in the gills of bivalves were studied.

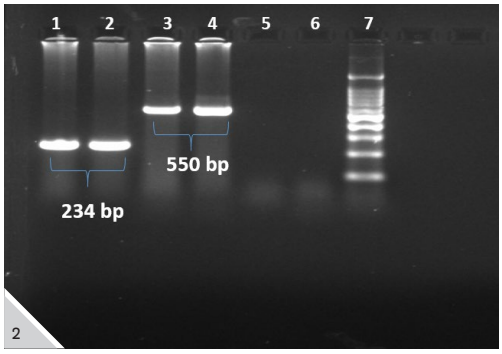
Bacterial infections: Infection with *Vibrio vulnificus* in cage cultured genetically improved farmed tilapia (*Oreochromis niloticus*) was studied. Genotyping based on *vvhA* gene revealed that the isolate belonged to genetic type 1. LD_{50} was calculated as 2.1 X $10^{5.1273}$ CFU/fish and 2.1 × $10^{6.123}$ CFU/ml in injection and immersion routes respectively. Serum survival studies of the pathogen in naive tilapia serum explained the increase in infective capacity of *V. vulnificus* at higher temperatures.

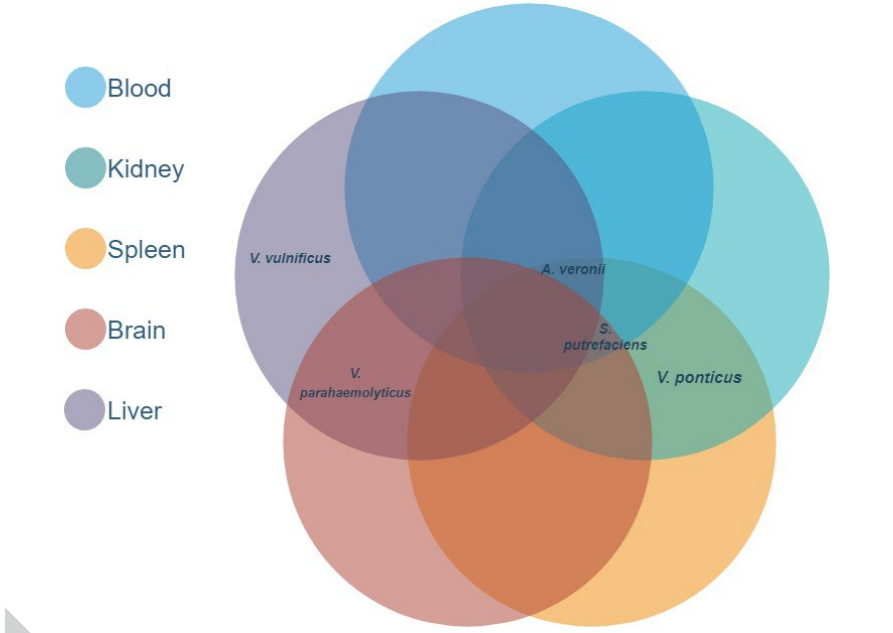
Streptococcus agalactiae infections were recorded from cage reared *O. niloticus*. LD_{50} was calculated as 6.5 X $10^{6.65}$ CFU/ fish following injection challenge. Clinical signs, histopathological changes, microbiological, molecular and virulence characteristics of the pathogen was also studied. Most predominant pathological changes were observed in spleen.

A resurgence of epizootic ulcerative syndrome (EUS) was reported from brackish water fishes of Kerala, subsequent to the 2018 floods. The resurgence occurred three decades

after the primary outbreak in the state. Mainly five fish species (*Mugil cephalus*, *Scatophagus argus*, *Platycephalus* sp., *Liza* sp. and *Epinephelus malabaricus*) were infected, of which involvement of *E. malabaricus* in natural outbreaks has not been reported earlier. Confirmatory diagnosis was done as per OIE protocols. Co-infection of EUS with three previously undocumented fish pathogens, *V. ponticus*, *Shewanella putrefaciens* and *V. parahaemolyticus* was also reported.







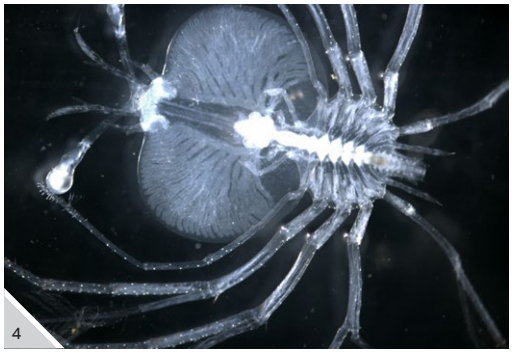
Infections with *Shewanella algae* and *V. harveyi* were recorded from *Trachinotus blochii* at Karwar. Fishes exhibited excessive mucus production on skin, bilateral exopthalmia, ocular hyperemia and distended stomach. Infections with *V. harveyi* and *V. parahaemolyticus* were reported from Visakhapatnam. Symptoms included haemorrhage in caudal area with complete loss of scales, excess mucus secretion and pale and inflamed liver.

Vibrio infection leading to nodular swelling and rupture of hepatic lobules in Phyllosoma III was observed in lobsters at Chennai.

Two strains of *Photobacterium damselae* ssp *damselae* and one strain of *V. harveyi* isolated from diseased cobia were characterized for biochemical, molecular, antibiotic sensitivity and enzymatic features. The study revealed multi drug resistance against *V. harveyi*. All strains were partially or completely resistance towards Ampicillin, but were sensitive to Chloramphenicol, Tetracycline, COT, Meropenem, Gentamicin and Ciprofloxacin. The multiple antibiotic resistance (MAR) pattern of the isolates was 0.25 for *V. harveyi*, and 0.125 for both the strains of *P. damselae* ssp *damselae*. Extracellular products were harvested from the test isolates and protein profiling was done. Enzymatic activity of the ECPs, intracellular proteins and released proteins in the supernatant were compared. The study revealed that *V. harveyi* exhibited high enzymatic activity.

Sequential pathology of *V. alginolyticus* in *L. calcarifer* was studied. Samples of liver, kidney, spleen and gill were taken at regular intervals (0, 2, 4, 6, 8, 10, 12, 24, and 48 Hours Post Challenge) for histopathological and microbial evaluation. Though, detectable lesions were not observed in tissues up to 10 Hours Post Challenge, after 12 HPC,

Fish Health and Marine Bioprospecting



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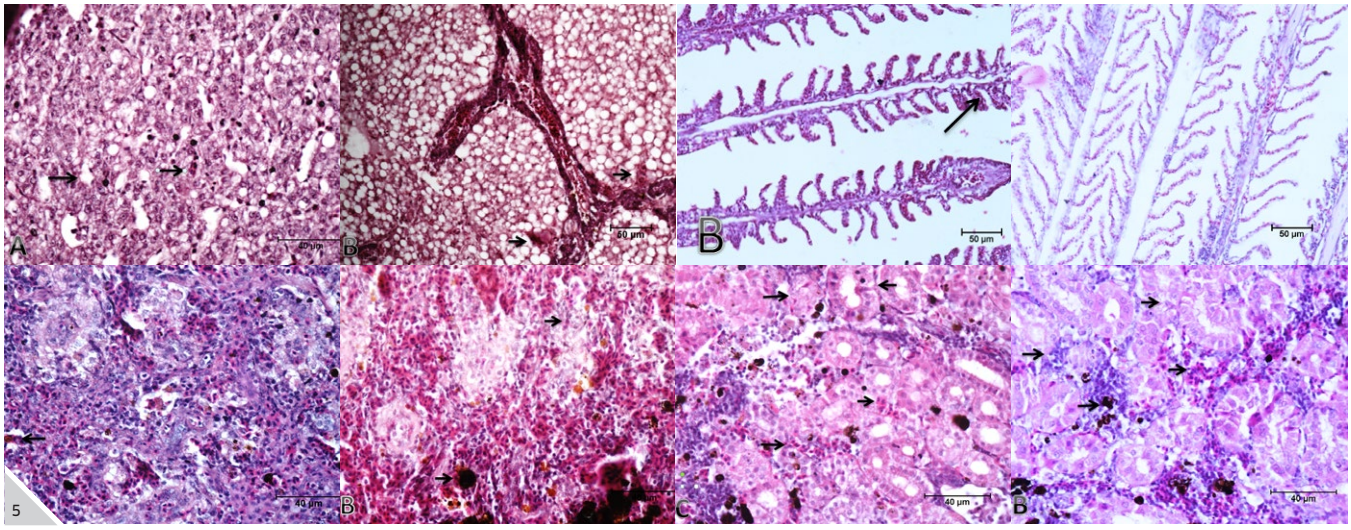

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1. Penetrating hyphae in ulcerated tissues of EUS affected fish
2. *A. invadans* specific PCR for confirmatory diagnosis of EUS
3. Classic Venn diagram representing shared bacterial species among different tissues
4. Luminiscent phyllosoma III of sand lobster
5. Sequential pathology of *V. alginolyticus* infection in *L. calcarifer*

serious pathological changes including sloughing of epithelial cells, thickening and clubbing of gill lamellae, haemorrhage, congestion, necrosis, infiltration, interstitial nephritis and tubular degeneration, and hemosiderin deposits were observed in various tissues studied.

Expression profile of immune genes of Asian seabass exposed to temperature stress was studied. The immune-related genes chosen for analysis by qPCR were, MHC class IIb, C- IIb, MHC class IIa, HSP70, HSP90, Cathepsin-L and Caspase-1.

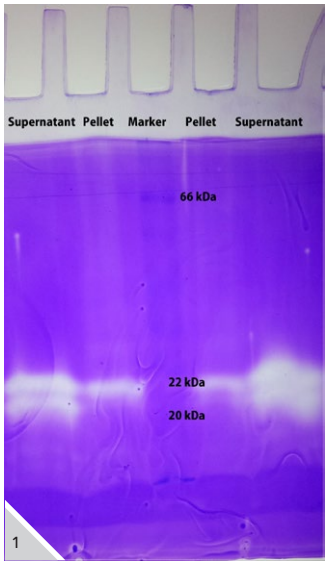
Studies on the virulent genes of *V. alginolyticus* revealed that the bacteria showed 100% resistance to Ampicillin, Penicillin and Oxytetracycline whereas intermediately strong resistance was exhibited against Polymyxin B, Colistin, Cephalosporin and Kanamycin. Tetracycline and Doxycycline were the most effective antimicrobials against *V. alginolyticus*. The results obtained in PCR experiments for *V. alginolyticus* virulence genes showed positive results in the amplification of Tox RS gene and Vpi gene. Two fragments corresponding

to virulent genes Tox RS F1R1 of product size 1347bp and Vpi F1R1 of product size 680bp were amplified from Test as well as reference strains of *V. alginolyticus.*

Isolation of hydrolytic enzyme and lipase producing microbes from the gut of *Crassostrea madrasensis.* A total of 20 cultures were isolated, purified and tested. Fifteen isolates were positive for amylase, 14 isolates were positive for lipase while none of the isolates showed any activity against cellulase.

Supernatants from cell-free culture of *Perkinsus olseni* cultures revealed protease activity; two proteolytic bands with molecular weights ranging from 20 to 22kDa were detected in the supernatants by zymography. *P. olseni* cells were positive for amylase activity.

Osmotic adaptation and expression profile of selected osmotic responsive genes were studied in *Etroplus suratensis.* When the fish was adapted to fresh water from 18 ppt, Aldo-keto reductase family 1 expression was reduced nearly 0.6 fold; RbBP 1/LBP1 protein showed 0.7 fold less expression; Enolase & ADP-ATP translocase reduced 0.75 fold and 0.65 fold respectively; HSP 90 expression level increased (0.3 fold); Inositol Monophosphatse (IMPA), Isocitrate dehydrogenase, L-Rhamnose binding lectin and Serine/ Threonine protein phosphatase showed a serious drop (nearly 0.8 fold) in their expression level while solute carrier protein gene expression decreased 0.75 fold. When the fish was adapted to seawater from 18ppt, Aldo-keto reductase family 1 expression increased nearly 1 fold; RbBP 1/LBP1 protein showed high expression (2.5 fold and 4.5 fold); Enolase & ADP-ATP translocase showed 0.5 fold and 1 fold increase respectively; HSP 90 expression level increased 2.5 fold;



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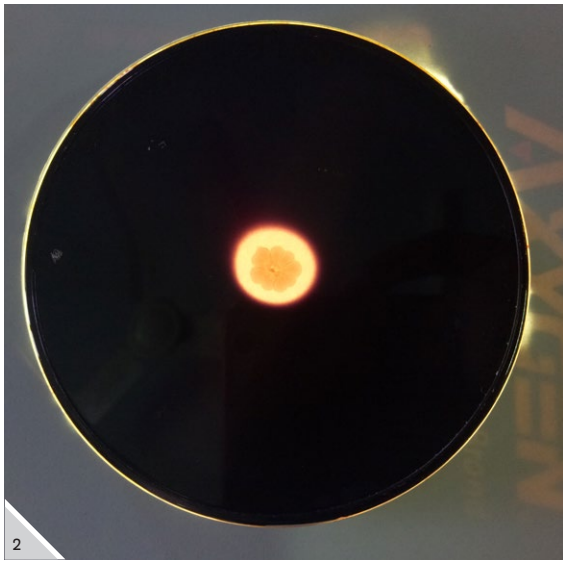
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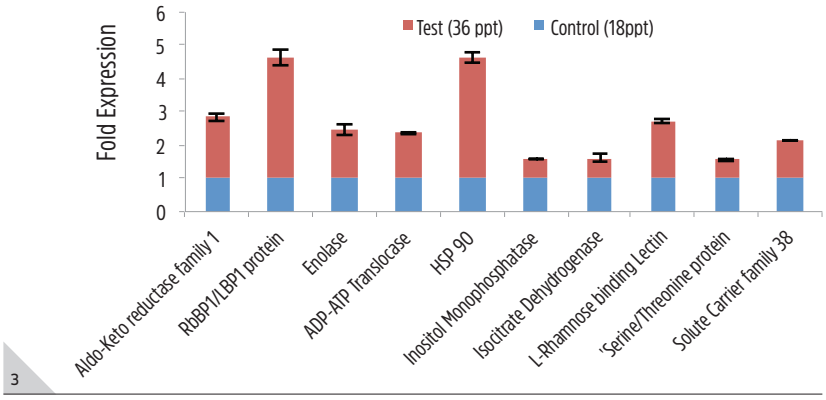

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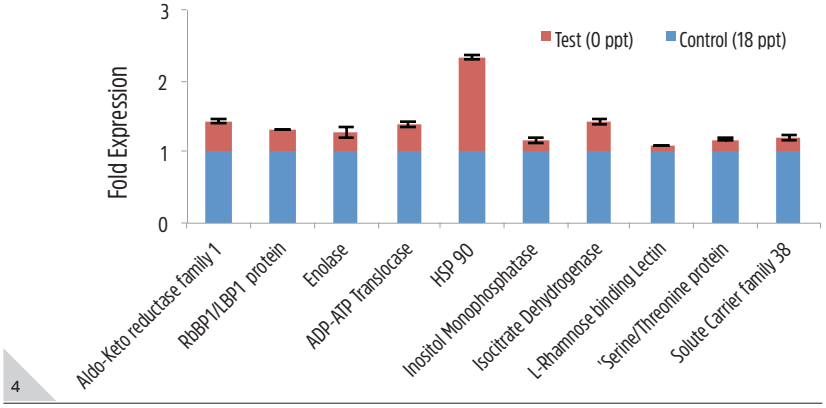

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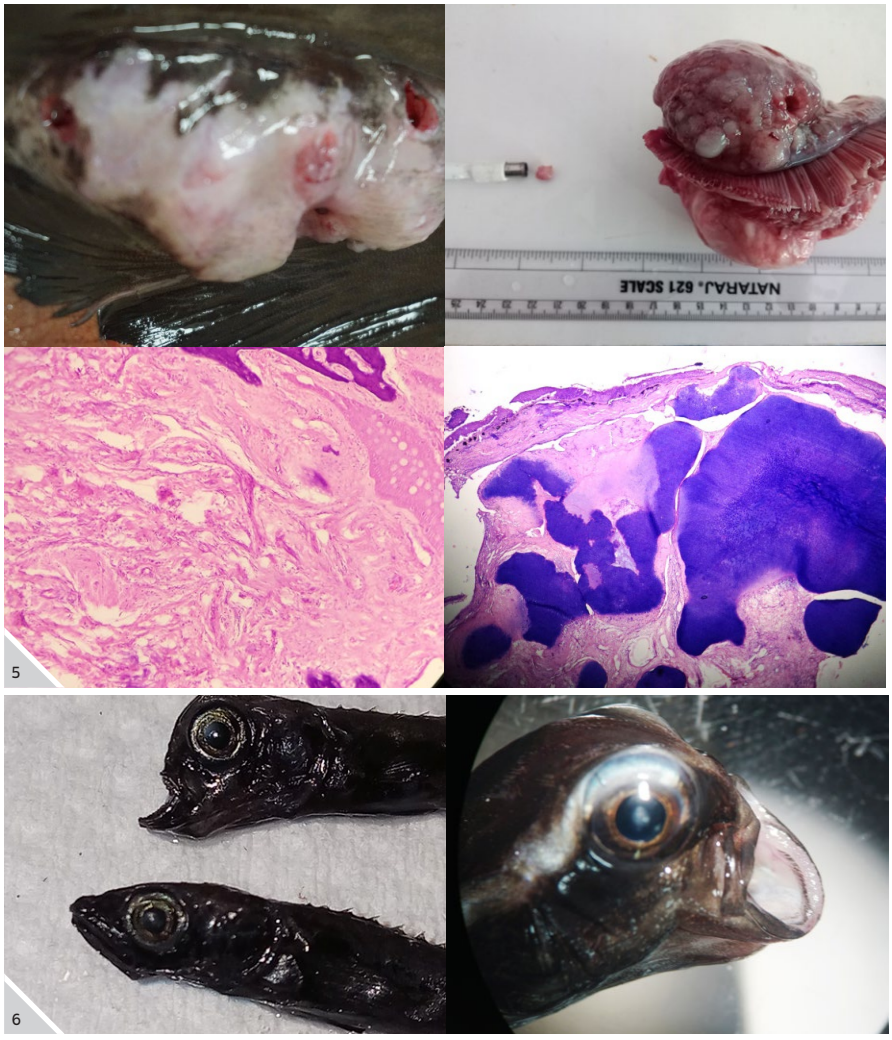
Fish Health and Marine Bioprospecting

1. Protease activity of *P. olseni*
2. Amylase activity of *P. olseni*
3. Relative expression profile of selected osmotic responsive genes in the gills of *Etroplus suratensis* exposed to fresh water as compared to brackish water
4. Relative expression profile of selected osmotic responsive genes in the gills of *Etroplus suratensis* exposed to marine water as compared to brackish water
5. Tumours in cobia
6. Deformities in cobia fingerlings



Inositol Monophosphatse (IMPA), Isocitrate dehydrogenase, L-Rhamnose binding lectin and Serine/ Threonine protein phosphatase showed a serious drop while L-Rhamnose binding lectin showed 0.25 fold increase.

Neoplasia: Incidence of tumours was reported in *Rachycentron canadum* from Mandapam. A cauliflower-like growth was observed in the gill rackers of cobia. Cytology of smears grouping of spindle shaped basophilic cells. Histologically, the section revealed fibrous tissue proliferation and hyperchromatic nucleus admixed with cartilage and was diagnosed as Fibrochondroma. In another case, a hard, solid growth was observed on the caudal fin of cobia. Cytology of smears showed collagen and basophilic mucus cells. Histologically, the section revealed replacement of entire stratum compactum and dermis with osteocytes and osteoid structure. Osteocytes were hyperchromatic with vacuoles formation indicating dermal fibro-osteoma.

Deformities were observed in hatchery reared cobia fingerlings, the upper maxilla was shortened and reduced compared to normal. Radiograph of the anomalies showed thinning of skull bone and deviation of upper maxilla.

Health management

Developed a model based on serum biochemical attributes of *L. argentimaculatus* to find its applications in health monitoring. Basal reference intervals for nine relevant serum biochemical parameters in cage reared

Fish Health and Marine Bioprospecting

1. Immunisation of cobia fingerlings
2. Mussel farmers meet at Edayilakkad
3. "Perkdetect", a LAMP based diagnostic against *Perkinsus* infections in bivalves

L. argentimaculatus in comparison with its wild counterpart were established. Higher inter-subject variability of serum glucose level makes it unfit as a health index for the species. Ecotype had a significant role on modulating serum biochemistry (except on serum glucose and SGOT levels), while gender had no effect. Accordingly summary statistics and ecotype specific reference intervals were calculated for these parameters. SGOT was found to have the potential to be applied as a health index for *L. argentimaculatus* irrespective of ecotype studied. Consistency, minimum intra-ecotype variability coupled with results of PCA analysis, makes serum protein as the best fit for ecotype specific health index.

In lobster culture, bacterial loads showed an increase during two phases of maximum water temperatures in May-July and lowest salinity period in December-January. Husbandry protocols with steady water temperatures of 27-28 °C is essential for nursery phase and continuous low salinity (26-28 ppt) leads to moult death syndrome and increased tail rot. Clam meat used as feed acts as a possible source for increased *Vibrio* load in lobster culture tanks. Experiments were conducted using clams treated with garlic extract, and preliminary results are promising with decreased bacterial load in tanks. However further studies are required for confirming the results.

Mass immunization against vibriosis was carried out in cobia fingerlings by intra-peritoneal injection of a multivalent vaccine. A booster dose on 35th DPV further enhanced the antibody levels and extended the protection. The vaccinated fishes neither showed stress nor mortalities indicating that the regular epizootics of vibriosis, usually occurring during the months of July to September (pre-monsoon), could be successfully prevented by vaccination and proper sea cage farming management.

National Surveillance Programme for Aquatic Animal Disease (NSPAAD): Under the National Surveillance Programme for Aquatic Animal Diseases, regular screening of wild and farmed bivalves for OIE listed pathogens, *Perkinsus olseni, Bonamia ostreae* and *Marteilia refringens* were carried out along the east and west coasts of India including Lakshadweep Islands.

A total of 1370 wild bivalve samples belonging to 15 species were collected and screened. *P. olseni* was observed in *Perna viridis, P. indica, Paphia malabarica, Geloina bengalensis* and *Anadara granosa* while *P. beihaiensis* was observed in *P. viridis, P. malabarica* and *G. bengalensis.* Mixed infections were observed in *P. malabarica, P. viridis* and *G. bengalensis.* The prevalence of *Perkinsus* infections in wild bivalves was 24.67%. A total of 1024 farmed bivalve samples were screened during the period. Overall prevalence of *Perkinsus* infections was 77.59%. Both *P. olseni* and *P. beihaiensis* as well as

Fish Health and Marine Bioprospecting

mixed infections were observed. Bivalves from Lakshadweep Islands were free from *Perkinsus* infections. Infections with *Marteilia* and *Bonamia* were absent in the screened populations.

A mass awareness programme was conducted for mussel farmers at Edayilakkad, Kasaragod district for creating awareness among the farmers to adopt better culture and management practices.

All India Network Project on Fish Health: Information regarding the usage pattern of drugs and chemicals in aquaculture was collected through a questionnaire based survey. The results indicate that drugs/chemicals are not generally used in farms in Kerala.

Biosafety evaluation of Emamectin benzoate was carried out in *T. blochii* with treatment doses ranging from 50 to 500µg/kg biomass. Tissue morphological changes were studied using histopathology.

An economic loss assessment study based on loss/mortalities in mussel farming in Kasaragode district was carried out. Losses due to mortalities and reduced production during the period ranged from 62-78% on an average.

Screening of imported marine ornamental fish for OIE listed pathogens was carried out and all the samples were negative.

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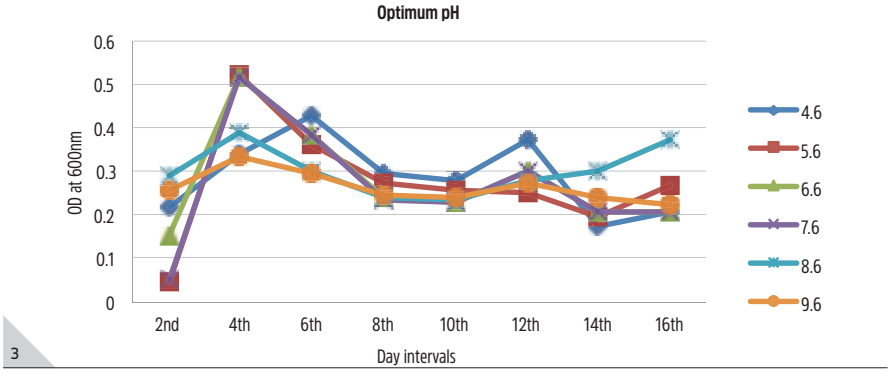

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ICAR-Consortia Research Platform on Vaccines & Diagnostics:

Experiments were conducted to establish the optimum conditions for *in vitro* culture of *Perkinsus*. 35ppt salinity, pH 5.6-6.6 and 50mM Hepes/3.6mM sodium bicarbonate buffer system appeared to be optimum for maximum growth. Pure cultures of *P. olseni* and P. *beihaiensis* were established and scaling up was done by cell culture in nunc flask. Mass cultured cells were harvested for polyclonal antibody production.

Developed "Perkdetect", a LAMP based diagnostic against *Perkinsus* infections in bivalves. The diagnostic is capable of detecting single copies of DNA template of both *P. olseni* and *P. behaiensis* and is more sensitive than RFTM and PCR (using primers and conditions recommended by OIE). External validation and field testing of 'Perkdetect' has been completed and the product is ready to be released.

Studies on the development of vaccine against Vibriosis is progressing.

Bioprospecting

Nutraceutical to combat hypothyroid dysfunctionalities: Cadalmin™ Anti-hypothyroidism extract (Cadalmin™ ATe) from seaweed.

Cadalmin™ ATe is a nutraceutical product, which provides a unique blend of 100% natural marine bioactive ingredients with anti-hypothyroidism principles extracted from seaweed, using an ecofriendly "green" technology. Cadalmin™ATe is a natural remedy for hypothyroidism from marine source.

Preclinical trials showed no significant toxicity-related changes in renal or hepatic function, hematological indices and serum biochemical parameters in experimental subjects. The results also demonstrated a lack of test substance-related general organ or systemic toxicity and hypoglycaemic disorders following oral administration at a dose as high as 2 x 10^3 mg/kg/d. It has no side effects (LD_{50} > 5000 mg/kg BW) as proved from the preclinical and acute/ long term chronic toxicity studies on experimental subjects. The product was administered for evaluating toxicity studies and Lethal Dose 50 (LD_{50}) as a part of the safety evaluation. After 90 days of drug administration for sub-chronic toxicity studies, it was found that there was no mortality; no change in body weight, organ weight, food and water consumption and the LD_{50} of the product was greater than 5 x 10^3 mg/kg body weight. Gross findings of rat hepatic surface in control, MTZ induced hypothyroid and Cadalmin™ ATe treated groups showed that the nodules (fat deposits) were gradually decreased upon the treatment in MTZ induced hypothyroid rats. No significant alteration were observed in renal function tests, hematological parameters, serum electrolytes and lipid profile like triglycerides, HDL and VLDL. To determine the acute toxicity, the product was

1. Optimisation of pH: cell dencities of *P. olseni* at different media pH
2. Shri Radha Mohan Singh, Hon'ble Union Minister of Agriculture, releasing Cadalmin™ ATe on 16th July, 2018

administrated for 14 days and the results indicated that it did not produce any biochemical changes related to hepatic and renal function. It was also observed that administration of the product did not produce any clinical or behavior changes. The results suggest that Cadalmin™ ATe is non-toxic and is safe. Cadalmin™ ATe was released by the Hon'ble Union Minister of Agriculture, Shri Radha Mohan Singh on 16th July 2018 in the gracious presence of the Director General of ICAR, Dr. Trilochan Mahapatra at a function in National Agricultural Science Complex, New Delhi. The product has been out-licensed to a healthcare company for commercial production and marketing.

Seaweed-associated Firmicutes and Gamma-proteobacteria as prospective anti-infective agents against multidrug-resistant pathogens

The emergence of antibiotic-resistant bacteria and the need for novel, antimicrobial agents led to the investigation of new habitats to screen for anti-infective substances. A culture-dependent study to isolate bacteria from intertidal macroalgae thriving along the Southern coast of India resulted in the isolation of 148 strains that were screened for antibacterial activities against a wide spectrum of pathogens including multi drug resistant *Staphylococcus aureus* (MRSA) and Vancomycin resistant *Enterococcus faecalis* (VRE). Two of the most active strains with a zone of inhibition ≥ 30 mm on spot on lawn assay, belonging to the phyla Firmicutes and Gamma-proteobacteria, isolated from a Rhodophyceaen macroalga, *Hypnea valentiae* were selected for bioprospecting studies. They were further characterized as *Shewanella algae* MTCC 12715 and *Bacillus amyloliquefaciens* MTCC 12716, based on integrated phenotypic and genotypic analysis. The bacterial extracts exhibited significant antibacterial activity against MRSA and VRE with minimum inhibitory concentrations of 6.25-12.5 µg/mL. Type1 *pks* gene (MH157093) of *S. algae* and hybrid *nrps/pks* gene (MH157092) of *B. amyloliquefaciens* could be amplified. Antibacterial activity analysis combined with the results of amplified genes encoding for polyketide synthetase and nonribosomal peptide synthetase showed that these marine symbiotic bacteria have promising broad-spectrum activity and

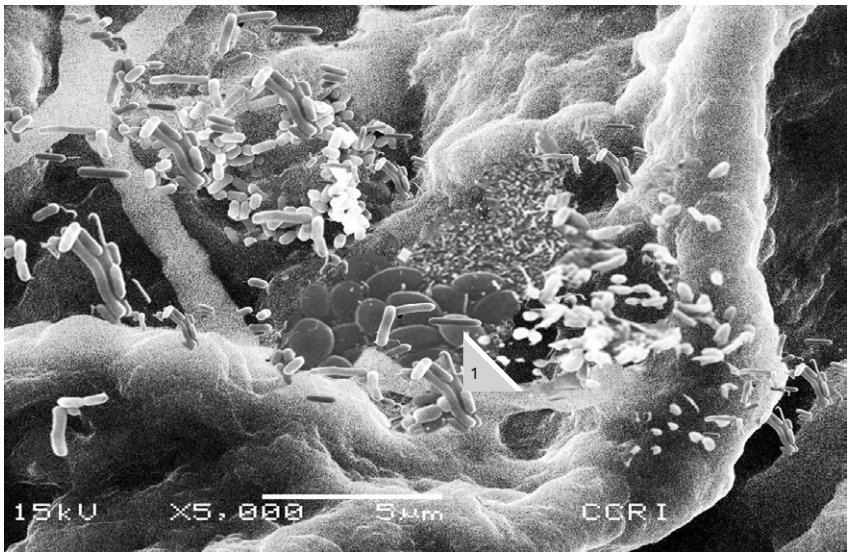
therefore, can be used against emerging antibiotic resistant bacterial infections.

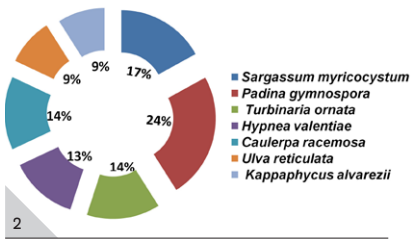
Cyclooxygenase-2 and 5-lipoxygenase inhibitory halogen derivatives from seaweed *Kappaphycus alvarezii*

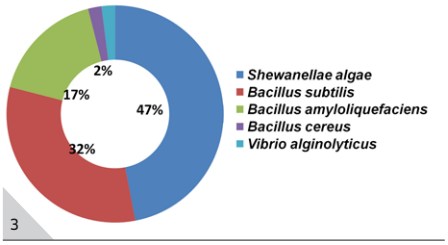
Two halogen derivatives, characterized as 2-butyl-7-4-(chloromethyl) cyclooct-1-enyl) hept-5-en-1-ol (1) and 4-(2-chloroethyl)-5-7-(methoxymethyl) undec-3-enyl) cyclooct-4-enone (2) were isolated from the organic extract of the seaweed, *K. alvarezii*. The studied compounds were evaluated for their inhibitory effects towards pro-inflammatory 5-lipoxygenase (5-LOX) along with cyclooxygenases (COX-1, 2) and free radical scavenging potential. The halogenated cyclooctenone displayed greater 5-LOX (IC_{50} 0.90 mg/mL) inhibitory activity when compared to the non-steroidal anti-inflammatory drug, Ibuprofen (IC_{50} 0.93 mg/mL). Similarly, selectivity indices of the studied compounds were higher (anti-cycloxygense-1 IC_{50}/anti-cycloxygense-2 IC_{50} ~ 1.06-1.07) when compared to Ibuprofen (0.44) and Aspirin (0.02). This is the first report on the structural characterization of unusual halogen analogues from *K. alvarezii* with dual cyclooxygenase-2 and 5-lipoxygenase inhibitory activities.

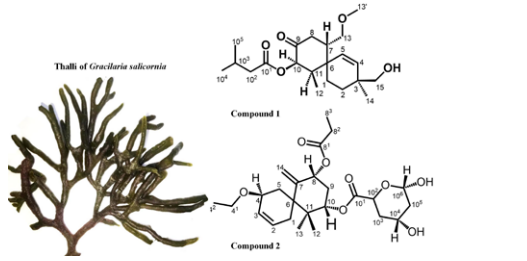
Bioactive compounds from marine macroalga *Gracilaria salicornia* as natural anti-inflammatory agents

This study involves the characterisation of two spiro[5.5]undecanes (1 and 2) with anti-inflammatory properties, from *Gracilaria salicornia*. These metabolites recorded bioactivity against 5-lipoxygenase (IC_{50} < 2.80 mM), whereas selectivity indices were greater (~1) than Ibuprofen (0.89) (p<0.05), which attributed selective anti-inflammatory potencies of the studied spiro[5.5]undecane derivatives against inducible cyclooxygenase-2 than constitutive cyclooxygenase-1. Three macrocyclic lactones bearing basic carbon framework of oxabicyclo[21.3.1] heptacosa-ene-diones (3-4) and oxabicyclo[19.3.1]pentacosa-ene-dione (5) were identified and characterised from the seaweed, *G. salicornia*. The 21-membered pyran-enclosed macrocyclic lactone, 4 displayed greater cyclooxygenase-2 (IC_{50} COX-2 1.13 mM) inhibitory activity than the 21-membered aryl macrocyclic lactone, 3 and 19-membered macrocyclic lactone, 5 (IC_{50} COX-2 ~1.2 mM).









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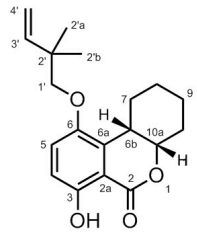

6-(2′,2′-Dimethyl)-3′-en-1′-yl-1′-oxy)-3-hydroxy-1*H*-benzo[c]chromene-2(10a*H*)-one

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1. Scanning electron micrograph of macroalgae with attached micro organisms.
2. Distribution of macroalgae-associated bacteria
3. Contribution of the individual representative bacterium as macroalgal association.
4. Bioactive compounds from marine macroalga *Gracilaria salicornia*
5. Chromene derivatives from muricid gastropod *Chicoreus ramosus*

1H-Benzochromenone from muricid gastropod, *Chicoreus ramosus* as a potential bioactive

Chromene derivatives with manifold structural framework and pharmacological properties were ubiquitous in molluscs of marine origin. A 1*H*-benzochromenone was isolated from the marine gastropod mollusc, *Chicoreus ramosus*. The compound was characterized as 6-(2',2'-dimethyl)-3'-en-1'-yl-1'-oxy)-3-hydroxy-1*H*-benzo[c]chromene-2(10a*H*)-one. Studies by employing the stable free radicals reported that the antioxidant activity (IC_{50} 1.4-1.6 mM) was comparable to α-tocopherol (IC_{50} 1.4-1.7 mM). Potential inhibitory activity of the studied compound against pro-inflammatory 5-lipoxygenase (IC_{50} 2.12 mM) was recorded, whereas its inhibitory properties against carbolytic α-amylase (IC_{50} ~0.72 mM) was comparable with that displayed by acarbose (IC_{50} 0.43 mM).

Development of small molecular weight angiotensin-II converting enzyme inhibitor from marine organisms

Research Project: EF3

The study demonstrated marine microalgae as valuable natural sources of bioactive compounds with antihypertensive activities. Optimized culture techniques were developed for the mass culturing of microalgae belonging to Chlorophyceae (*Dunaliella salina, Chlorella salina*), Prasinophyceae (*Tetraselmis tetrahele*), Haptophyceae (*Isochrysis galbana*), and Bacillariophyceae (*Chaetoceros calcitrans*). The microalgal cells were subjected to exhaustive organic and aqueous extractions to yield various crude organic extracts. Among the organic extracts of the microalgal species considered in this study, *C. salina* was selected for further chromatographic purification and characterization of small molecular weight molecules, based on the various *in vitro* assays. The nuclear magnetic resonance-guided dereplication of organic extracts of the studied species appropriately recognized the co-linearity between the bioactive potential and downfield electronegative functionalities. The organic extract of *C. salina* was sequentially fractionated by column chromatography to yield methyl-4'-(5-hydroxy-2-(3ª-methylhex-3ª-en-2ª-yl)-4a,8a-dihydro-2H-chromen-6-yl)butanoate (1), 4-methyl-5-(4'-hydroxy-2'-methylbut-1'-en-1-yl)-7-(3ª-methylpent-1ª-en-2-yl)-3,4,6,7,8,8a-hexahydro-1H-isochromanone (2), 4-(1'-Hydroxyethyl)-7,8-dimethyl-1-oxo-octahydrobenzo[c]oxepin-6-yl-(4a-methylpent-3a-enoate) (3), and 3-hydroxy-4-(4'-hydroxypentyl)-5-(2ª-methylbutanoate)-7-methyl-6,7-dihydrobenzofuran (4).

Brood stock and Seed Production

Breeding and Seed Production of Cobia, *Rachycentron canadum*

Research Project: MDN/HCY/18

Five successful spawning inductions of cobia produced fertile eggs ranged from 0.7 to 9.0 lakhs eggs per spawning and the mean percentage of fertilization and hatching were 56.4 and 57.2, respectively. Water quality parameters were maintained within the optimal range through indigenously designed filtration systems. The broodstock fishes were fed with high

1

quality fresh squid and crab meat. A total of 28,200 cobia fingerlings were produced and about 10,600 fingerlings were supplied to farmers and research institutions for farming, field demonstrations and broodstock development. About 17,600 fingerlings are being reared for supplying to farmers to carry out demonstrations on open sea cage farming.

Breeding and Seed Production of Silver Pompano, *Trachinotus blochii*

Broodstock of Silver Pompano *Trachinotus blochii* (6 sets) were maintained in 10 ton capacity FRP tanks fitted with photo thermal and water quality management systems. Periodic cannulation was carried out in the female fishes to assess the gonadal maturity. A total of 27 successful spawning inductions were carried and fertilized eggs were obtained. The total number of eggs per spawning ranged from 0.20 to 2.60 lakhs. The fertilization rate ranged from 15.2 to 98.2% and the percentage

2

3

Production of cobia fingerlings in hatchery

S. No	Date of spawning	No. of eggs (lakhs)	Fertilization (%)	Hatching (%)	No. of larvae used for fingerling production	No. of fingerlings produced
1	18.06.2018	1.2	11.7	20.0	2800	200
2	23.11.2018	2.0	77.0	69.0	100000	8100
3	04.01.2019	9.0	66.7	67.0	100000	9000
4	23.02.2019	0.7	66.7	60.0	30000	2400
5	02.03.2019	5.0	60.0	70.0	100000	8500
Total		17.9			332800	28200

Supply of cobia seed under technology demonstration

Details of the beneficiaries under demonstration of the technology	Quantity of Seed (nos.)
Mr. Thominique, Thangachimadam, Tamil Nadu	1500
Mohd. Noor, Munaikadu, Tamil Nadu	1500
Mr. SeeniMohideen, Mandapam, Tamil Nadu	1000
Mr. Naga Arjun, Maraikkayarpattinam	600
Director, DceSA, TNJFU, Tamil Nadu (BSN stage)	5000
CMFRI, Mandapam RC for Research &Broodstock development	1000
Total	10600

1. Release of seeds at Sangumal, Olaikuda in Palk Bay
2. Packing of Cobia seeds
3. Transportation of Cobia fingerlings

Brood stock and Seed Production

of hatching ranged from 31.0 to 95.2. A total of 2.6 lakhs silver pompano fingerlings were produced and supplied to farmers, fishermen and research institutions of Karnataka, Kerala, Tamil Nadu, Pondicherry, Andhra Pradesh and West Bengal for farming and field demonstrations. About 30,000 fingerlings were used for conducting research experiments at CMFRI centers.

Production of silver pompano fingerlings in hatchery

S.No	Date of experiment	No. of eggs (lakhs)	Fertilization per cent (%)	Hatching per cent (%)	No. of larvae used for fingerling production	No. of fingerlings produced
1	04.04.2018	2.10	98.2	48.5	100000	17400
2	07.04.2018	2.0	77.3	70.6	60000	9400
3	05.05.2018	0.20	60.0	76.9	100000	18040
4	07.05.2018	2.40	90.1	69.4	100000	17100
5	12.06.2018	2.10	67.4	96.6	50000	9500
6	12.06.2018	2.50	83.3	92.9	50000	9800
7	04.07.2018	2.10	80.9	92.9	50000	10600
8	16.07.2018	1.60	75.0	83.3	50000	10100
9	16.07.2018	2.35	93.9	93.5	50000	9900
10	06.08.2018	1.00	60.0	66.7	40000	5000
11	08.08.2018	2.40	91.6	90.9	50000	9200
12	18.08.2018	2.20	93.8	93.3	100000	14500
13	18.08.2018	2.60	89.7	92.3	50000	12800
14	18.08.2018	0.80	75.0	66.7	50000	3100
15	12.09.2018	0.65	15.4	50.0	5000	1100
16	23.10.2018	0.70	28.6	50.0	10000	2100
17	23.10.2018	2.10	28.7	41.5	25000	4300
18	23.10.2018	2.20	31.8	57.1	40000	4500
19	24.11.2018	2.55	79.1	81.6	100000	16000
20	24.11.2018	1.90	89.4	76.2	75000	14100
21	26.12.2018	2.05	97.5	75.0	50000	9000
22	26.12.2018	2.05	95.1	89.6	50000	11900
23	26.12.2018	2.30	91.3	95.2	50000	10100
24	31.01.2019	2.25	93.3	95.2	100000	15100
25	31.01.2019	1.90	21.1	63.8	25500	3300
26	31.01.2019	4.50	98.0	91.5	100000	15400
27	31.01.2019	0.20	72.5	31.0	4500	1000
Total		50.8	–	–	1535000	264340

Brood stock and Seed Production

Supply of Pompano fingerlings under Technology Demonstration

Period	Details of the beneficiaries	Quantity (Nos.)
June-18	SFDC, Kolkata, West Bengal	20000
	Mr. Krishna RudraVarma, Andhra Pradesh	10000
	M/s Sriram Aquaculture, Pondicherry	18000
	SIC, NICRA, Kochi	2000
July-18	Mr. Dhanapal and Mr. Murugaiyan, Tamil Nadu	7000
September-18	Mr. Sunil, Kerala	10000
	Director, DSA, TNJFU, Tamil Nadu	18000
	M/s MSR Hatchery, Kakinada, Andhra Pradesh	25000
October-18	Director, DSA, TNJFU, Tamil Nadu	12000
	M/s MSR Hatchery, Kakinada, Andhra Pradesh	70000
	Mr. M.R.K. Raju, Andhra Pradesh	20000
January-19	SIC, Karwar RC of CMFRI, Karnataka	8000
February-19	Mr. Abilash, Ongole, Andhra Pradesh	10000
February-19	The Dean, FCRI, Tuticorin, Tamil Nadu	1100
Total		231100


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1. Distribution of Silver Pompano seeds to the beneficiaries
2. Transportation of Silver Pompano fingerlings

Breeding and seed production of orange spotted grouper *Epinephelus coioides*

At Visakhapatnam, Orange spotted grouper larval (metamorphosed) production has been consistently achieved with a survival rate of 12%. The size of the metamorphosed larvae after 40 days of rearing in the hatchery ranged from 2.5 to 2.9 cm in length and 0.25 to 0.30 g in weight. A total of more than 30,000 metamorphosed larvae produced in the last reporting year and from the metamorphosed larvae around 21,000 numbers of advanced larvae were produced with a survival rate of 70%.

1

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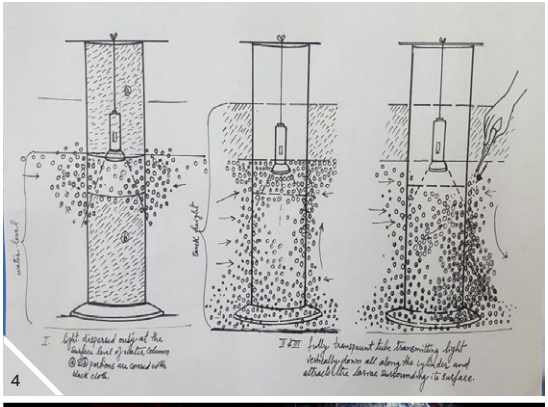
Seed production and sea ranching of Green Tiger Shrimp (*Penaeus semisulcatus*)

The Green tiger shrimp *Penaeus semisulcatus* seeds were produced at Mandapam using wild collected brooders from shrimp trawlers operated in Gulf of Mannar and Palk Bay. After spawning, nauplii were transferred to 5 ton capacity larval rearing tanks. Larvae were reared up to the stages between PL-10 and PL-20 and were used for sea ranching

Details of sea ranching of *Penaeus semisulcatus* during the year 2018-19

Date	Quantity	Location	In the presence of
28.12.2018	5 Lakhs (PL 15-30)	Kunthukal, GOM	Fishermen association leaders, fishermen and officials of State fisheries Department
31.01.2019	9 lakhs (PL 15-35)	Sangumal, Olaikuda	Shri. Muralidharan K., Member, Institute Management Committee ICAR-CMFRI, fishermen association leaders, fishermen and officials of State fisheries Department
07.03.2019	11 lakhs (PL15-25)	Villundi Theertham, Palk Bay	Shri. K. Veera Raghava Rao I.A.S. District Collector,Shri. K. Muralidharan, Member, Institute Management Committee ICAR-CMFRI, leaders of fishermen associations, fishermen and officials of State Fisheries Department
29.03.2019	8 Lakhs (PL12-15)	Thonithurai, Mandapam, Palk Bay	Fishermen association leaders, fishermen and officials of State fisheries Department



1. Sea ranching of green tiger shrimp at Thonithurai, Palk Bay
2. Sea ranching of seeds in the presence of Shri. K. Veera Raghava Rao, IAS, District collector, Ramanathapuram
3. Release of seeds at Kunthukal in Gulf of Mannar
4. PFT feeding method
5. Photo Feed Tube

programme to enhance the shrimp productivity and replenishment of natural stocks in Gulf of Mannar and Palk Bay. A total of 3.3 million shrimp post larvae were sea ranched in Gulf of Mannar and Palk Bay.

Seed production of sand lobster *Thenus unimaculatus*

At Chennai, three batches of sand lobster *Thenus unimaculatus* larvae were reared to final settlement level. A new feeding protocol - Photo Feed Tube (PFT) method–was attempted using fresh clam meat, with variation in feeding strategy. Under this new method, larval survival was found to improve and moult rates up to late PIV were found to be accelerated. The efficiency of feeding of the phyllosomal larvae is substantially increased by attracting them using a light kept in a hood. A glass tube with luminescent source close to 1000 lux attracted the larvae for feeding. This method of feeding is being standardized to increase the larval survival.

Breeding and seed production of marine ornamental fishes

At Kochi, production of hybrid *Amphiprion percularis* from the *A. percula* x *A. ocularis* pair was successfully achieved and morphometric differences of eggs, larvae and juveniles of the hybrid were documented. Initiation of hybridization between Maroon clown *Premnas biaculeatus* (female) and *Amphiprion ocellaris* (male) has been done. Super small rotifer *Colurella adriatica* was used as live feed to evaluate the growth and survival of larvae of marine ornamental fishes under captive condition. Broodstock development of marine ornamental Goby, Scissortail Dartfish, *Ptereleotris evides* is under way at Kochi. At Vizhinjam, breeding and larval rearing of Cloudy Damsel, *Dascyllus*

carneus was successfully carried out. Seed production of commercially important marine ornamental fishes *viz., Amphiprion percula, A. ocellaris, Amphiprion frenatus* and *Amphiprion sandaracinos* (Orange skunk clown) are being done at various CMFRI centres. Seed production and scaling up of the hybrid clown fish varieties *viz*., Platinum, Snow flake and Picasso clown are in progress at Mandapam regional centre. An amount of Rs. 2.297 lakhs was generated as revenue through sale of marine ornamental fish fingerlings.

Growth, development and survival of larvae of green tiger shrimp under different mixed algal regimes

An experiment was conducted to assess the growth and survival of larvae of green tiger shrimp, *Penaeus semisulcatus* under mixed algal feeding with microalgae/ diatoms *viz,* combination of *Chaetoceros calcitrans & Isochrysis galbana*, combination of *Chaetoceros calcitrans & Thalassiosira* sp, combination of *Isochrysis galbana & Thalassiosira* sp. and combination of all the three micro algae. The Protozoea I larvae of *P. semisulcatus* were stocked in 5 litre containers @100 Nos. per litre and feeding with different algal combinations were carried out in the concentration of 50000 Nos. of cells per ml in equal ratio of different species. The water quality parameters such as salinity, temperature and pH were maintained at 33-35ppt, 27-28°C and 8.0-8.3, respectively. The growth and development were assessed by random sampling of larvae and observed under microscope to assess the larval developmental stages from Protozoea I to Mysis III and the survival was recorded in each larval stage under different algal regimes. The results showed that the growth and survival were better under combination of *Chaetoceros calcitrans* and *Thalassiosira* sp. followed by combination of *Chaetoceros calcitrans, Isochrysis galbana* and *Thalassiosira* sp. Hence, Combination of two algal species *Chaetoceros calcitrans* and *Thalassiosira* sp. are suitable for larval rearing of *P. semisulcatus* upto PL stage.

Assessment of morphotype variations among the progeny of Designer clown fishes

Hatchery production of designer or hybrid clownfishes has been standardized at Mandapam. A general feature noticed in the progeny from breeding of designer clown fishes is that, there is a morphotype variation which is not yet understood fully. Hence a study was undertaken to delineate this variation. The progeny from every clutch of eggs was reared separately till the morphological differences were distinguishable. Then the percentage of each morphotype was calculated. The study is being continued to gather data from sufficient number of spawning so as to arrive at a concrete conclusion or inference.

Broodstock development and induced spawning trials in other prioritized species for mariculture

At Calicut, broodstock of *Acanthopagrus berda* collected from the wild off Korapuzha and Kadalundy Estuary, using cast net/ hook & line/trap were initially stocked in brood stock tanks. They were fed with fresh squid meat @ 5% of body weight. Female fishes weighing 650 to 1200 g and male fishes weighing 90 to 300 g were selected from the brood stock tanks for breeding trials. A total of 5 breeding trials were conducted. At Karwar, broodstock of marine

Platinum parents (Male and Female Platinum clown fish)

Morphotypes	Percentage occurrence of juveniles in the progeny			
	1	2	3	Average
Picasso	5.26	0	44.44	16.57
Platinum	94.73	100	31.48	75.40
Percula	0	0	24.07	8.02

Picasso parents (Male and female Picasso clown fish)

Morphotypes	Percentage occurrence of juveniles in the progeny							
	1	2	3	4	5	6	7	Average
Picasso	47.16	31.97	23.77	36.21	52	53.06	68	44.60
Platinum	0	9.3	30.06	0	14.66	10.2	1.33	9.36
Percula	52.83	58.72	46.15	63.78	33.33	36.73	30.66	46.03

1. ASP product developed by MBTD, CMFRI, Kochi

finfish *viz. Lutjanus argentimaculatus*, *Lutjanus johnii* (24 numbers) *Acanthopagrus berda* (70 numbers), *Acanthopagrus lates* (40 numbers), *Siganus canaliculates* (30 numbers), *Siganus vermiculatus* (34) brooders are being maintained in both 6 meter and 3 meter diameter GI cages at KRC's marine farm and in hatchery. Twenty sub-adults of john's snapper (0.5 to 2.0 kg) were collected from wild and stocked in sea cage for developing as brooders. They were fed on low value feed such as scad, sardine etc. A mini-recirculatory system was developed at the centre for broodstock development using a 10 ton FRP tank fitted with a sand filter, biological filter, U.V water treatment system, and protein skimmer.

Evaluation of an attenuated spray dried product (ASP) developed by CMFRI on the growth and immunity in pompano under low salinity

Growth and immunity of Silver Pompano (5.24g) juveniles were evaluated with newly developed attenuated spray dried product (ASP). Feeding was done up to apparent satiation twice daily at 10:00 h and 16:00 h. The survival in all treatments during the experiment was above 90 % without any significant differences among them. The responses such as final weight, WG%, FCR, PER and SGR were significantly affected due to dietary ASP. A better growth and feed utilization was observed in the group fed with 0.5 and 1% dietary ASP levels. Hence it can be concluded that ASP in the range of 0.5 to 1% in the diet has a positive effect on the growth of *T. blochii* juveniles. The effects on immunity have to be validated further by bacterial challenge tests, which is ongoing.

Mass production of live feeds

Marine microalgae

Stock cultures for 20 marine microalgal species are maintained at Kochi. Stock and mass culture of *Nannochloropsis salina, N. occulata, Isochrysis galbana, Thalassiosira chui, Chlorella salina, Dunaliella. salina, Chaetoceros Calcitrans, Pavlova* sp. are being carried out at Karwar, Calicut, Vizhinjam and Mandapam.

At Visakhapatnam, *Nannochloropsis salina* was cultured in different salinities ranging from 3-33ppt. Highest cell count of 30 million/ml was observed with 21ppt salinity after a culture of 4days at a temperature of 18^{0}C and light intensity of 200 lux. Flocculation of the *Chaetoceros* culture was performed in 500ml beaker with the adjustment of pH with 5N NaOH. The pH varied from 8.4 – 11.9. Flocculation efficiency was estimated at 4hrs from an aliquot of the medium which was collected for measuring optical density from a height of 10cm from the bottom of the beaker. The optical density of the aliquot was measured by UV spectrophotometer

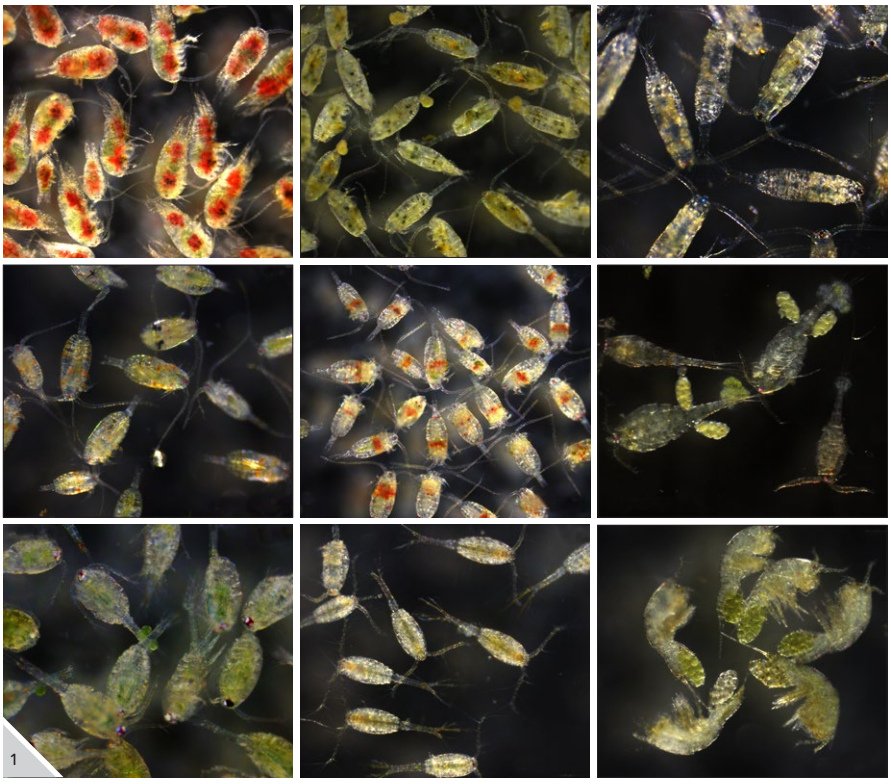
(Biotech Epoch 2) at a wave length of 750nm. The flocculation efficiency showed significant increase from initial pH of 8.4 to the induced pH of upto 10.2 and it was reduced at pH of 10.3 and henceforth became stationary upto pH of 11.9. The Evans Blue staining confirmed that the cells were individually dispersed upto induced pH of 10.2. So it is concluded that induced pH of 10.2 may be optimum with better flocculation efficiency for the harvesting of *Chaetoceros calcitrans* to maintain viable culture.

Marine copepods

At Vizhinjam, stock and mass culture of 8 species of copepods: Calanoid copepods *Acartia southwelli*, *Parvocalanus crassirostris cochinensis*, *Bestiolina similis*, *Pseudodiaptomus serricaudatus* and *Temora turbinata*, Cyclopoid copepod *Dioithona oculata* and *Dioithona* sp. and Harpacticoid copepod *Euterpina acutifrons* were carried out and supplied as live feed for larviculture. A consolidation of biological details and culture protocols of all 9 species of copepods has been published in the form of a book titled "Culture techniques of marine copepods" by CMFRI. GenBank submission of two species of copepods has been completed.

At Tuticorin, the biology and life history of calanoid copepod *Acartia southwelli* was documented. Its culture and use as live feed improved the survival of marine fish larvae.

The growth and fatty acid profile of copepod *Parvocalanus* sp. was studied with three different feeds: *Isochrysis* sp., *Chaetocerous* sp. and *Nannochloropsis* sp. Among the feeds, *Chaetocerous* sp. showed maximum growth. Total of 35 fatty acids were observed in copepods fed with these algae. The EPA and DHA content were highest in *Isochrysis* sp.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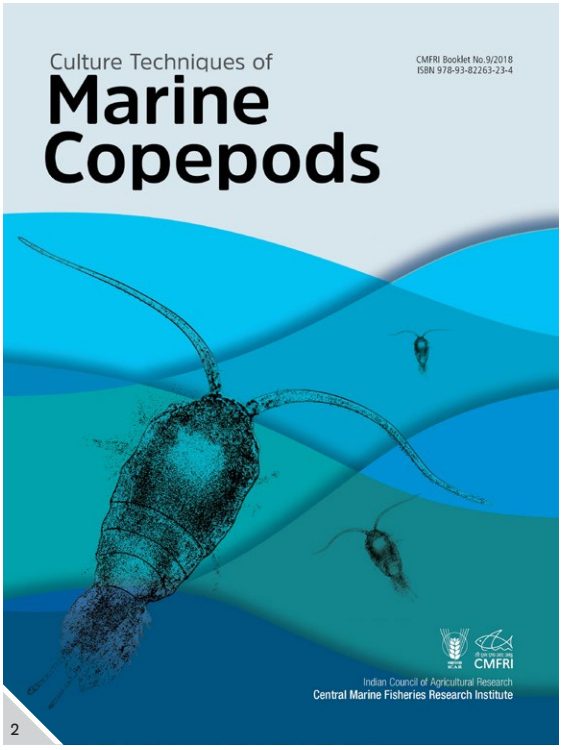

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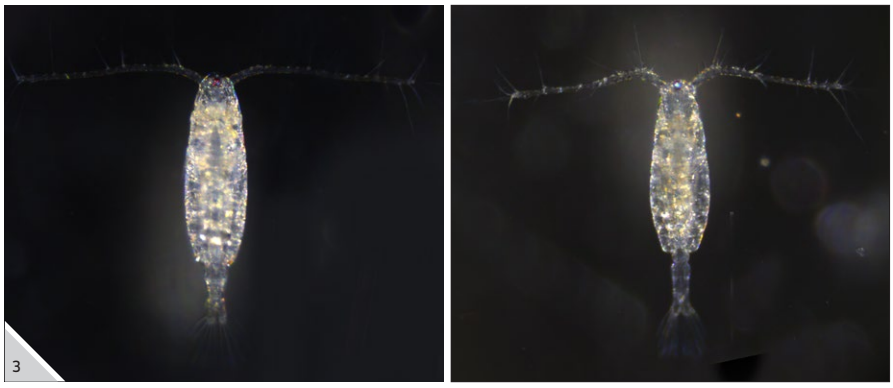
Brood stock and Seed Production

1. Copepods cultured at Vizhinjam and Tuticorin
2. Book on Copepod culture
3. *Acartia southwelli* (female and male)



and *Chaetocerous* sp. fed copepods, respectively. The EPA and DHA content in copepod fed with different diets are given below.

Growth, reproduction and nutritional profile of rotifer fed with different feed were studied. Rotifer fed with *Nannochloropsis* sp, *Isochrysis* sp, yeast, and combination of *Nannochloropsis* sp. & *Isochrysis* sp. and *Nannochloropsis* sp, *Isochrysis* & yeast was studied. Among all feed, rotifer fed with *Nannochloropsis* sp. showed better growth and reproductive state on fourth day of culture. Total of 35 fatty acids were recorded in rotifer fed with algae and it was less in yeast. The EPA and DHA content in rotifers fed with various diets are given below.

The EPA and DHA content in copepod fed with different diets

Feed	EPA (%)	DHA (%)
Isochrysis sp.	6.00	8.89
Chaetocerous sp.	0.38	14.52
Isochrysis sp. + *Chaetocerous* sp.	0.39	13.57

The EPA and DHA content in rotifers fed with various diets

Feed	EPA (%)	DHA (%)
Nannochloropsis sp.	9.05	0.91
Isochrysis sp.	1.68	14.09
Yeast	3.65	4.37
Nannochloropsis sp. + *Isochrysis* sp.	4.61	2.12
Nannochloropsis sp. + *Isochrysis* sp. + Yeast	4.55	1.15

Growout Technologies

Cage culture of finfishes

Research Project No: MDN/CGE/19

Orange spotted grouper *Epinephelus coioides*

Cage culture of orange spotted grouper was done at Visakhapatnam coast. Two HDPE circular cages were stocked at a stocking density of 12 nos/m^3 and 6 nos/m^3 with hatchery produced grouper seeds having an average length of 12.2± 0.28 cm and weight of 30.70± 2.34 g. The fishes were initially fed with floating

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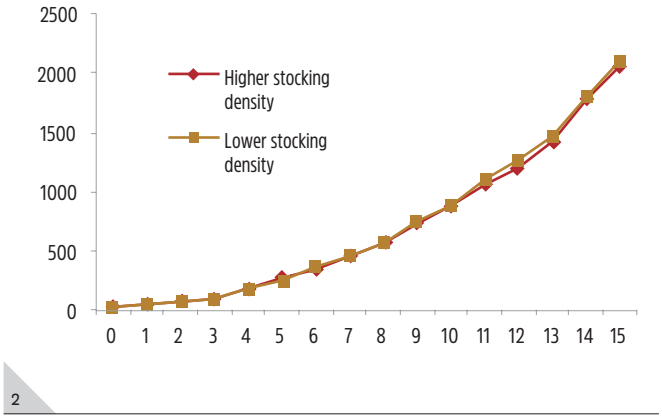
Growout technologies



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1. Arial view of sea cage farm at Mandapam RC of CMFRI
2. Growth of orange spotted grouper in sea cage at different stocking densities
3. Harvested orange spotted grouper from sea cage
4. Farmed Giant trevally Caranx ignobilis

feed pellet containing 40 % protein for 3 months. Subsequently, low value fishes were fed to the stocked fishes @ 7-10% body weight. The fishes stocked @ 6 nos/m^3 and 12 nos/m^3 had grown to a size of 2,105 ± 105.35 g and 2,047 ± 157.53g respectively after 15 months of culture period with percentage weight gain of 6.757% and 6.568% respectively. After 15 months of grow-out, the fishes attained an average size 2.1 kg in weight. The average specific growth rate during the culture was found to be 0.93%/day. Feed conversation ratio during the initial culture period when fed on floating feed pellet was 1.0:1.46 and during the later culture period when fed on low value fish was 1: 6.7. Production of 16.30 kg/m^3 and 8.40 kg/m^3 was obtained at 12 nos/m^3 and 6 nos/m^3 stocking densities after 15 months of culture period.

Giant trevally *Caranx ignobilis*

Cage farming of the giant trevally *Caranx ignobilis* was carried out at Chinnakuppam in Kancheepuram district, TN. Nearly 250 fingerlings (3-4 inches length and 20-30 g weight) of the giant trevally were collected from Palar river and 200 fingerlings each of the mangrove snapper *Lutjanus argentimaculatus* and Asian seabass *Lates calcarifer* were stocked in cages. The harvested biomass was 80 Kg, with a net survival rate of 80%. About 10% of the harvested trevallies had grown to >650 g weight, 60% had grown to 500-650 g weight and 30% weighed <500g in 160 days of culture.

Seabass *Lates calcarifer*

Field level cage culture demonstration of Asian seabass, *Lates calcarifer* was carried out using low cost fixed cages at Nagnathwada and Small Masjid, traditional fishing villages in Karwar. Galvanized iron (GI) frame cages of dimension 6 x4x2 m and 2.5x2.5x2 m were erected in the Kali estuary. The cages were stocked with nursery reared Asian seabass fingerlings

(average size - 30 g) at a stocking density of 15 no /m^3 and 32 no/m^3. The fishes were reared for a period of 132 days and fed with low value fishes at 6% of their body weight. Fishes attained an average marketable size of 465 g and 575 g in 132 days at Nagnathwada and Small Masjid respectively. A total production of 203 kg was obtained from the cage with a survival of 75%, average growth rate of 3.3 g/day, SGR of 1.94%, FCR of approximately 1:3.1 at Nagnathwada. A total production of 244 Kg was obtained from the cage with a survival of 84%, average growth rate of 4.05 g/day, SGR of 2.01%, FCR of approximately 1: 2.57 at Small Masjid, Karwar.

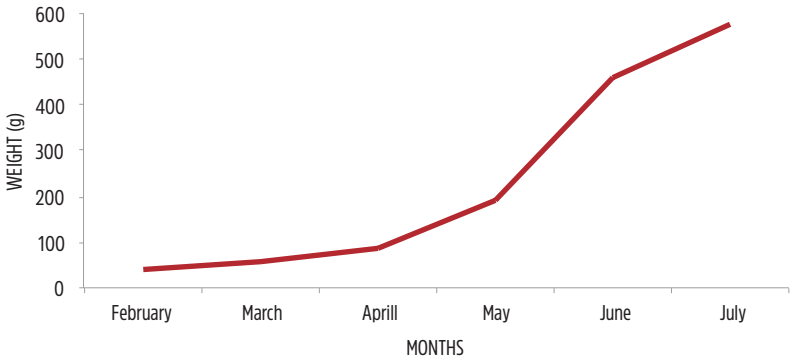
Demonstration of sea cage farming at Perinjanam, Thrissur, Kerala

At Perinjanam, Kerala open sea cage fish farming was demonstrated with participation of farmers. One thousand juveniles of Seabass (*L. Calcarifer)* having a size range of 12-15 cm were stocked in a 6 m dia cage during October. Regular feeding, monitoring and net maintenance were carried out by the fishermen with technical guidance from CMFRI. Trash fishes were as feed given for rearing throughout the culture period. Seabass had attained 400 to 500 g weight in 6 months of rearing. The fishes were harvested in March.

1. Harvested seabass from cages
2. Harvesting of sea cage
3. Harversted fish
4. Growth sea bass in cages

Cage farming of seabass at Small Masjid, Karwar

Size of the cage	2.5 m x2.5 m x 2m
Total number of fishes stocked	400 (32 / m 2)
Total number of fishes harvested	336
Survival	84 %
Days of culture	133
Average stocking size	40 g
Average harvest size	575 g
Specific growth per day(%)	2.01
Total harvest	244 k g
Total feed given	628 kg
FCR	1: 2.57



Sea cage farming of Asian Seabass (*Lates calcarifer*) at Mandapam

Sea cage farming demonstrations were carried out in participatory farmers' sites using 6 m diameter GI cages with the net cage depth of 4 m. at four locations, two cages in each location *viz.*, Mandapam (Gandhi Nagar), Maraikkayarpattinam, Vedalai and Erwadi, coastal villages of Gulf of Mannar in Ramanathapuram district, Tamil Nadu. Nursery reared Asian Seabass, *Lates calcarifer* fingerlings with a mean initial body weight of 25 g were stocked at a stocking density of 8 fishes per m^3. The fishes were harvested after eight months of culture period and the fishes attained an average growth of 1.54 Kg in weight.

Growout technologies

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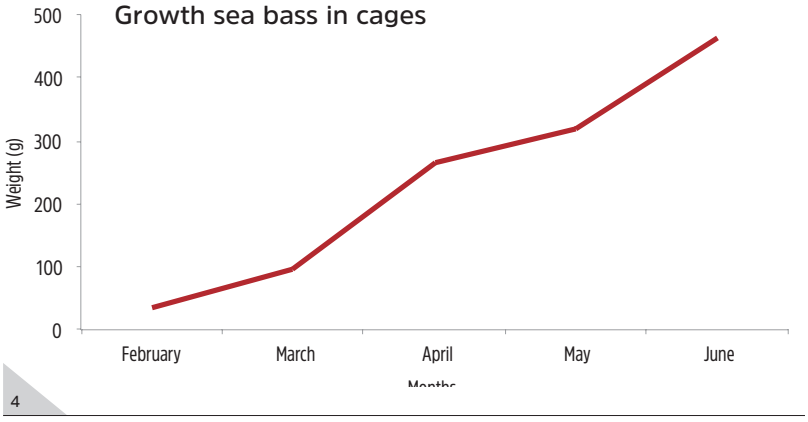
Details of cage farming at Nagnathwada

Size of the cage	6m x 4m x 2m
Stocking density	15 / m3
Survival (%)	75.6 %
Days of culture	132 days
Average stocking size	30 g
Average harvest size	465 g
Specific growth per day (%)	1.94
Total harvest	203 g
Total feed given	640 kg
FCR	1: 3.1



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Sea cage farming of Asian Seabass (Lates calcarifer) at Mandapam

Parameters	Mandapam	Maraikkayarpatnam	Vedhalai	Erwadi
Mean body weight at stocking (g)	25.0	25.0	25.0	25.0
No. of seed stocked	1800	1800	1800	1800
No. of fishes harvestedw	1472	1516	1366	1329
Survival at harvesting (%)	81.78	84.39	75.89	73.83
Mean weight at harvesting (kg)	1.52	1.62	1.59	1.45
Total weight at harvesting (kg)	2237.0	2460.0	2172.0	1927.0

Growth of *Lutjanus argentimaculatus* in cages

Weight gain (g)	360.97
Length gain (cm)	19.62
Average growth rate (g/day)	2.6
SGR (%/day)	1.37
K (Condition factor)	1.8

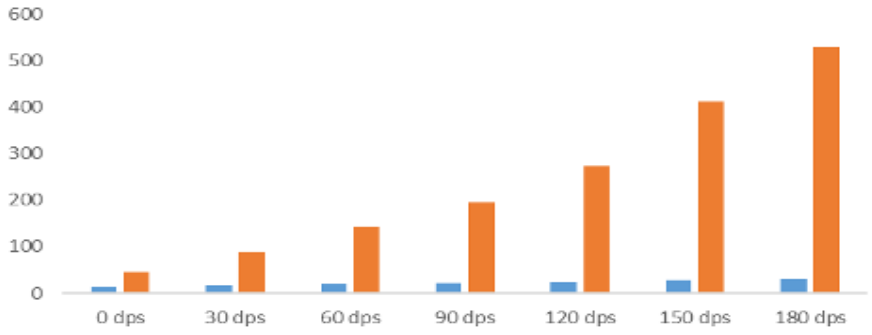
Asian seabass grow-out culture in Sea cages at Sippikulam and Keelavaipar, Tuticorin

Total production of 2.21 tonnes of seabass was achieved from cage farming in 10 nos of GI cages by the 10 fisher groups (4 persons in each group) under the scientific farming practices and guidance of Tuticorin Research Centre of CMFRI.

The average weight of the harvested seabass was 1.25 kg, with a Specific Growth Rate (SGR) of 4.03±0.18 (% d-1). Survival of 68 % during the culture period of 330 days and revenue of Rs. 10.09 lakhs was realised through sale of fishes.

Red Snapper *Lutjanus argentimaculatus*

Three hundred numbers of wild seeds of *Lutjanus argentimaculatus* collected from Ratnagiri coast were transported to Karwar and stocked in 6 m dia. GI cage for farming. After 180 days of culture, fishes attained an average weight of 528.33 g and average length of 30.85 cm from an average initial weight of 44.65 g and average initial length of 14.04 cm.



Pink-ear emperor *Lethrinus lentjan*

A batch of 45 days-old seed of the pink-ear emperor *Lethrinus lentjan*, produced in the hatchery of ICAR-CMFRI's Vizhinjam Research Centre was transported to Kovalam Field Laboratory, CMFRI Chennai. The seeds were stocked in two flat bottom FRP tanks of 1ton capacity @ 150 per tank. Seed of *Lethrinus* collected from creeks adjoining Kadalur Chinnakuppam village were also stocked simultaneously in a different tank in the laboratory and in a net enclosure at Kadalur Chinnakuppam. Initial observations indicated that some of the fishes were injured. After several attempts with shelters and hideouts, the

Growout technologies

1. Pen farming - Vedhalai
2. Cage farming -Mandapam
3. Cage farming at Tuticorin

rearing system was modified by providing soft sediment in situ bedfilter substrate. The fishes remain in hideouts and bury themselves into the sediments. Stocking and handling larger numbers in the nursery phase were found to be easier in the new system.

Pearl spot–*Etroplus suratensis*

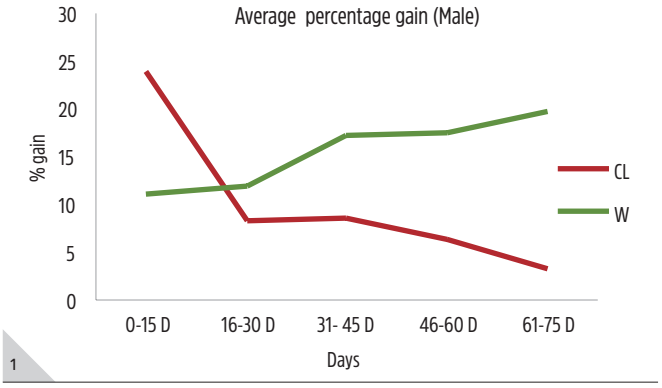
Cages of dimension 4x4x2.5m were installed at Mujukunnu (Akalapuzha, Korapuzha estuary) with participation of farmers.. The cage was stocked with 250 numbers of *Etroplus suratensis* of 5-10 gm size. After 12 months of culture period the fish grown to a size of 150-175 gm. 36.8 kg of *Etroplus suratensis* were harvested from the cage.

Farming of Spiny lobster *Panulirus homarus* in sea cages and pens

Wild collected juveniles of spiny lobster *Panulirus homorus* with an average size of 61.5 grams were stocked in sea cages and pens installed at Mandapam and Vedhalai, Tamilnadu. Two cages with 6 m diameter, 3.5 m cage depth and mesh size of 30/40 mm inner and outer nets were installed at Mandapam in the Gulf of Mannar and four numbers of pens with 6x6 m dimension with 2 m depth and 20 mm mesh size were installed at Vedhalai, Gulf of Mannar. Hide-outs were kept both in cages and pens for controlling the cannibalism during moulting. Feeding was carried out with trash fishes and clams @ 10% of the body weight. The lobsters attained an average weight of 160.0 g in 120 days, with a final survival of 94 per cent in cages. Whereas, the lobsters attained an average weight of 171.2 g in 120 days of farming, with a final survival of 97 per cent in pens.

Growth study in cage reared lobsters *Panulirus polyphagus*

Growth performance of male and female lobsters reared in cages were assessed in a 75 day growout trial at Verval, Gujarat. Uniformed sized male and female lobsters (112.9±10.1 gm and 132.03±5.51 mm)



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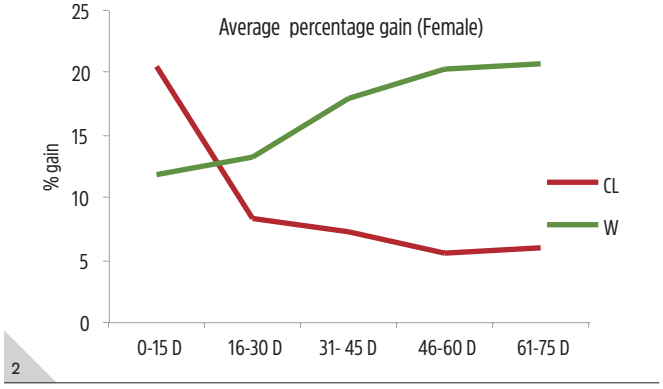

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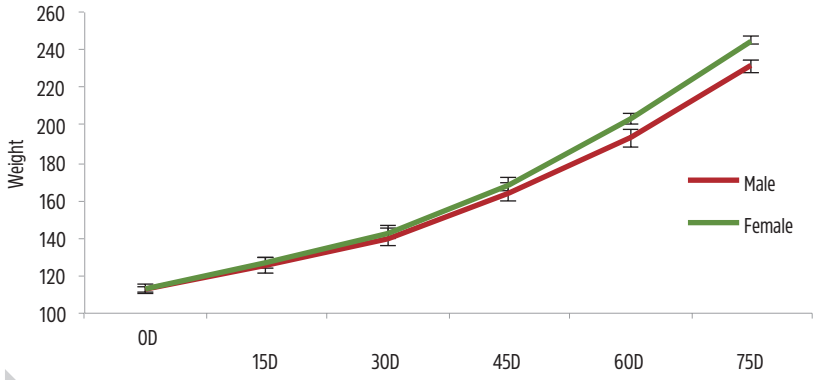
were stocked. After the grow-out culture period of 75 days the males attained an average weight and length of 231.17±13.4 gm and 191.47±6.79 mm, respectively. The weight gain for females was much higher 245.14±114.38 gm whereas the length gain was comparable 193.38±6.93 mm. The maximum weight gain was recorded during 61-75 days for both males and females.

The percentage weight gain shows increasing trends from 0-15 days to 61-75 days. An inverse trend was observed for the percentage gain in length which tend to decrease as the culture progresses in both male and female

Growth in terms of length gain and biomass gain remains similar in males during most part of culture period. Females started putting more weight during the terminal phase unlike length which remains similar to that of males. A significantly higher mean weight for females was observed on 75th day post stocking.

Increasing slope of weight gain (dw/dt) curve shows an efficient utilization of the exponential growth phase of the lobster in terms of weight (common feature for both Male and Female). The value of lobsters rests mostly in terms of weight and hence more weight gain is an indication of better condition factor, a desirable culture attribute.



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Bacterial counts in seaweed and water samples

Sample	Total Aerobic Count	Presumptive Vibrio Count
Healthy K.alvarezii	2.8 x 102 cfu/gm	<1
Infected K. alvarezii	3.0 x 103 cfu/gm	2.0 x 103 cfu/gm
Bleached K. alvarezii	3.6 x 103 cfu/gm	3.5 x 103 cfu/gm
Water from uninfected area	<1	<1
Water from infected area	TNTC	TNTC

Development of re-circulating aquaculture system (RAS) for nursery rearing of marine finfish

A re-circulating aquaculture system was developed for nursery rearing of orange spotted grouper and Indian pompano. Indian pompano fingerlings (0.2-0.25 g weight) and orange spotted grouper fingerlings

(0.4-0.7 g) were grown to the average size of 3.5-4.0 and 3.0- 3.5g respectively after one month of culture in RAS. The different stocking densities of Indian pompano were experimented and found that 10,.000 metamorphosed fry of Indian pompano can be stocked in 8 m^3 of the water volume in a 10 t capacity tank. Later, as the fish juveniles grow, the stocking density reduced to 5,000 numbers after 15 days of stocking.

Integrated Multi-Trophic Aquaculture (IMTA)

Farming of *Kappaphycus alvarezii* was carried out using 2x2 m bamboo raft near snapper cage to develop an IMTA model integrating these two speceis. An event of bleaching was noticed in early January 2019 in the farmed *Kappaphycus alvarezii* at the marine farm of Karwar Research Centre of ICAR-CMFRI. Samples of healthy, infected and bleached thalli were collected and subjected to microbial analysis. Water samples from the area of bleaching as well as from the area with healthy seaweed were also collected for the analysis of associated bacterial communities. Bacteria were isolated from seaweeds and water using different media. Biochemical tests were carried for preliminary identification. The results

1. Average percentage gain in CL and W of male lobster during sampling intervals.
2. Average percentage gain in CL and W of female lobster during sampling intervals.
3. Increasing slope of weight curve as the culture progresses
4. 10 t capacity tanks connected with recirculating system for nursery rearing
5. Indian pompano juveniles in the re-circulating tank
6. *Bacillus* sp. from healthy farmed *Kappaphycus alvarezii* specimen, *Dominant Vibrio* from bleached, infected samples
7. Infected silver pompano
8. Gonad of cobia having both testicular and ovarian tissues


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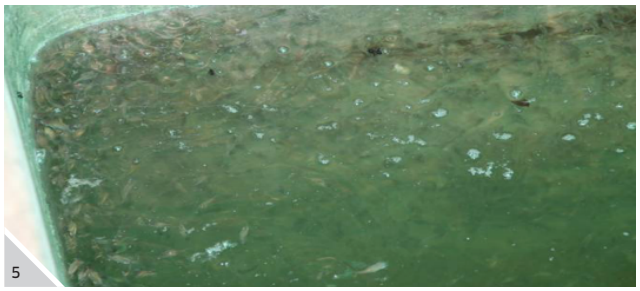
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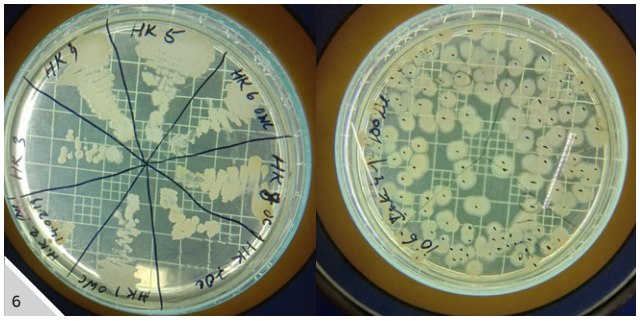
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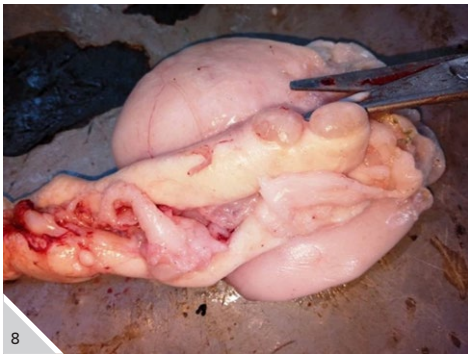
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indicated ten times higher total aerobic count of bacteria in the infected and bleached samples when compared to the healthy sample. It was noteworthy that only gram positive bacteria were found from healthy samples whereas gram-negative bacteria dominated the infected and bleached samples. The bacteria isolated from healthy *K. alvarezii* was dominated by *Bacillus* sp. whereas *Vibrio* group was predominant both in the infected as well as bleached individuals. Important environmental parameters such as temperature, pH and salinity were also recorded and compared with the data corresponding to period prior to the event of bleaching in seaweed. This preliminary study indicates a possible interplay of environment and microbes as a cause of bleaching in red seaweed, *K. alvarezii.*

Prophylatic studies

Pathogenicity of *Amyloodinium ocellatum* was studied in silver pompano, *Trachinotus blochii*, which was found to be the major cause for mass mortality in nursery rearing. The infected fish showed signs of flashing behaviour, distress and loss of appetite. The gills and body of silver pompano were infested with *A. ocellatum.* The body was found to be thin and emaciated. Gills of infected fish showed excessive mucus and pale discolouration. It is presumed that fish died due to severe erosion of gill membranes hampering gaseous exchange.

Chloroquine phosphate is an antimalarial compound, is reported to be effective in control of *A. ocellatum* at a concentration of 10 mg/l. Prophylactic studies with a chemical chloroquine phosphate (CQP) and its toxicity experiment was conducted. Initial studies revealed that 10mg/l Chloroquine phosphate concentration more effective control of *A. ocellatum* without any mortality. It was also found that the number of spores (tomont stage) in gills greatly reduced at 10mg/l concentration. 20mg/l, 30mg/l and 40mg/l concentration also effectively reduce the spores (tomont stage) of *A. ocellatum* but at the same time mortality of *Trachinotus blochii* increased due to its toxicity.

Observation on intersex in cage farmed cobia, *Rachycentron canadum*

Intersex in Cobia (*Rachycentron canadum*), a gonochoristic species, was recorded in a fish cultured in sea cages at Mandapam Regional Centre of CMFRI. Out of three cobia brooders maintained in the broodbank for spawning purpose, a male brooder (based on cannulation biopsy) when dead, was found with a pair of testes with different morphological features (testes tissues embedded with nodular structures). Histologically, the section revealed both ovarian tissues and lumen of the seminiferous tubules with fully matured spermatozoa. The central part of the testes (non-nodular structure) revealed fully developed matured spermatozoa. But the nodular part showed majority of the ovarian tissues with minimal testicular tissues. This is the first observation of intersex gonads in the gonochoristic cobia from Indian waters.

1. Sea cage with biofouling
2. Cage frames with biofouling
3. Biofouling in HDPE pipes of the sea cage
4. Barnacles in the HDPE pipes of the sea cage
5. HDPE pipes coated with antifouling paint
6. Experimental cage tied with the antifouling coated HDPE pipes

Experiments on the effect of antifouling coating in sea cages

Fouling in sea cages can result in severe economic loss to the farmers through net occlusion, weight addition, disease risk, etc. Hence an experiment is being carried out in combating this hindrance in sea

Investigations of diseases and disorders in sea cage farming.

The details of investigations on the mortalities occurred in various sites of cage farming of cobia.

Location	Period	Percent mortality	Predisposing factor for the mortality	Cause of death
Munaikaadu, Palk Bay	March 2019	2%	Occlusion by barnacles in the inner net and higher sea water temperature (34°C)	Higher temperature, low water exchange through clogged nets and high stocking density
Mandapam, Gulf of Mannar	January 2019	2%	Stress due to water turbidity	*V. parahaemolyticus* and some non-specific


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cage farming by using antifouling coatings incorporated with booster biocides. The commercially available antifouling coating, TORPEDO, a vinyl antifouling paint with cuprous oxide and organic biocides as active ingredients for long term resistance to weed, shell and animal fouling was used to top coat the HDPE frame of the sea cages. Initially, three pieces of HDPE pipes were coated with the antifouling coating and tied to hang along the cage frames. The cage frames are considered as control and the coated pieces of HDPE pipes are periodically observed for assessing the fouling.

Delineating the compensatory growth pattern in stunted fingerlings of Marine finfishes for production enhancement

Research Project: MDN/GRO/22

Evaluation of compensatory growth pattern in long term stunted fingerlings in low saline condition and marine condition were carried out using fingerlings (<5g size) of silver pompano *Trachinotus blochii* at Mandapam. Control was maintained at a stocking rate of 20/m^3 providing feed at 10 % of body weight and the fishes were reared for 60 days. Fishes were fed with an artificial diet (45

% crude protein) and were stunted for 90 days. During the stunting process the fishes were stocked in 3 tonne FRP tank at a stocking rate of 100/ m^3 providing commercial pellet feed at 3 % of body weight. During the post-stunting period the stunted fishes were further reared for 90 days at a stocking rate of 20/m^3 providing feed at 15% of body weight.

In the stunting experiment in marine condition, the stunted fishes shown a higher SGR / day (%) (2.62) compared to control (0.92) indicating the compensation of growth. Gain in weight in stunted fishes also indicates that the treated fishes shown retarded growth during the stunting phase but has completely compensated the growth during the post stunting phase. The total biomass was significantly higher in control.

In the stunting experiment in low saline condition at Karwar, SGR / day (%) indicates the stunting of the fishes (0.77) compared to control (1.99). Gain in weight in 90 days stunted fishes indicates that the treated fishes shown retarded growth during the stunting phase but could not initiate the compensatory growth during the post stunting phase and mass mortality occurred during the post stunting phase.

Gain in weight in 90 days stunted silver pompano (dotted line during stunting) in marine condition

Bivalve mariculture

Research Project: MFD/MOL/17

Popularization of eco-friendly molluscan farming strategies

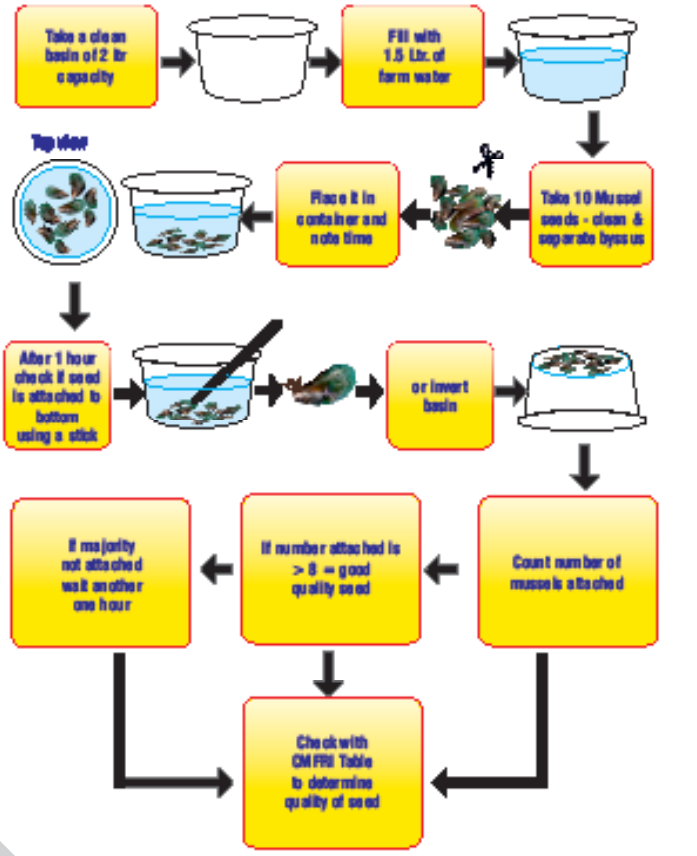
In Tamil Nadu, Technical assistance in site selection, selection of beneficiaries setting up farms, seeding and management was given to the selected beneficiaries of Cuddalore Chinna Kuppam, Kottaikadu, and Pulicat–Senjiamman koil fishing villages. In Kerala, Mussel farming training was given to the fishers of Taliparamba at the Kuppam river.

Oyster farming was demonstrated to the fishers of Padanna and three racks were constructed with 1500 rens as the first demonstration of oyster farming in the area. A meeting of the 150 mussel


1

1. Oyster rens being transported from Padanna to Sindhudurg.
2. Inforgraphics on mussel seed quality test
3. Mussel farming training being given to the fishers of Taliparamba at the Kuppam river

Growout technologies



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growers of Kasargod, 'Mussel farmers meet' was held at Edayilakkad on 9th February 2019 under the aegis of National Surveillance Programme for Aquatic Animal Diseases (NSPAAD) and CMFRI.

New Mussel rope and Oyster ren Trade – Kerala and Karnataka

Mussel ropes were transported from Udupi to Goa and Maharashtra since November 2018. About 6000 ropes were transported in 3 months. 2600 rens with the oyster spats were transported from Padanna in Kasargod district of Kerala to Sindhudurg area in Maharashtra for farming. One month grown rope were sold @ Rs. 250/rope of 60-70 cm (profit Rs. 150/rope).

New oyster farms were set up in Moothakunnam and Chettuva. Remotely settled oyster farm with 105 strings and 5 mussel farms were put in Moothakunnam and 2 new mussel farms at Chettuva in Ernakulam district.

About 15 tonnes and 4.5 tonnes of shell on oysters and mussels were harvested, jet washed thoroughly and depurated in the Moothakunnam Value Added Production (VAP) unit and about 86 kg of depurated oyster meat and 36.5 kg of mussel meat were sold through the ATIC of CMFRI. The revenue generated was Rs 75,492.

CMFRI 2016 Advisory on mussel farming – GOK Order 2018

The CMFRI advisory on mussel farming practices advocated were adopted and a Govt. of Kerala notification was brought out. Info-graphics on the mussel seed quality test and mussel seed collection and transportation were also published.

All India Network Project on Mariculture

A network of 12 centres associated with AINP-M are conducting mariculture research under two major themes (1) Grow out technologies and (2) Hatchery Technology with CMFRI as the lead Institute. Apart from six centres of CMFRI, Central Island Agriculture Research Institute (ICAR-CIARI) Port Blair was included as a participating centre from 2017-18 onwards along with 5 other participating centres from State Agricultural Universities.

1

All India Network Project on Mariculture

1. Net changing in a marine cage at Jaigad
2. Implantation of tags in the body of *Lutjanus argentimaculatus*
3. Reading the tag implanted in the body of *Lutjanus argentmaculatus*
4. Cannulation for checking the maturity stages of *L. argentimaculatus.*

Development of hatchery technology

Pink ear emperor fish (*Lethrinus lentjan*)

Brood stock of *Lethrinus lentjan* were maintained in the Reciruclating Aquaculture Systems (RAS) at Vizhinjam centre and regular spawning was reported during this year. Larval rearing was standardised and hatchery produced seeds were regularly supplied to beneficiaries. About 1 million spawn were supplied for rearing in hatcheries in other locations and a portion of the spawn was sea-ranched with an intention to replenish the stock. .

Red snapper (*Lutjanus argentimaculatus*)

Mangrove red snapper (*Lutjanus argentimaculatus*), is a potential species for mariculture. Broodstock development of *L. argentimaculatus* of the family Lutjanidae were progressing in 10t indoor Recirculatory Aquaculture System (RAS) and were grown from juvenile to a size range of 53 to 60 cm during a rearing period of 2 years at Vizhinjam Centre of CMFRI. Fishes were tagged and cannulated regularly to assess the gonadal maturity.

Brood stock of *Lethrinus nebulosus* and *L. microdon* were also collected and stocked in RAS to develop brood stock.

Rabbitfish (*Siganus vermicularis*)

Broodstock of Rabbitfish *Siganus vermicularis* were developed at College of fisheries, Ratnagiri and 100 numbers of fishes were transported to Karwar hatchery of CMFRI for induced spawning and larval rearing experiments.

All India Network Project on Mariculture

Breeding trails of *Siganus vermiculatus* (Valenciennes, 1835)

The wild collected *Siganus vermiculatus* (150-800 g-63 Nos.) from Ratnagiri coast were reared in broodstock development cages at marine cage farm, Karwar RC of ICAR-CMFRI. The fishes were fed with formulated pellet feed enriched with cod liver oil and Vitamin E during this period.


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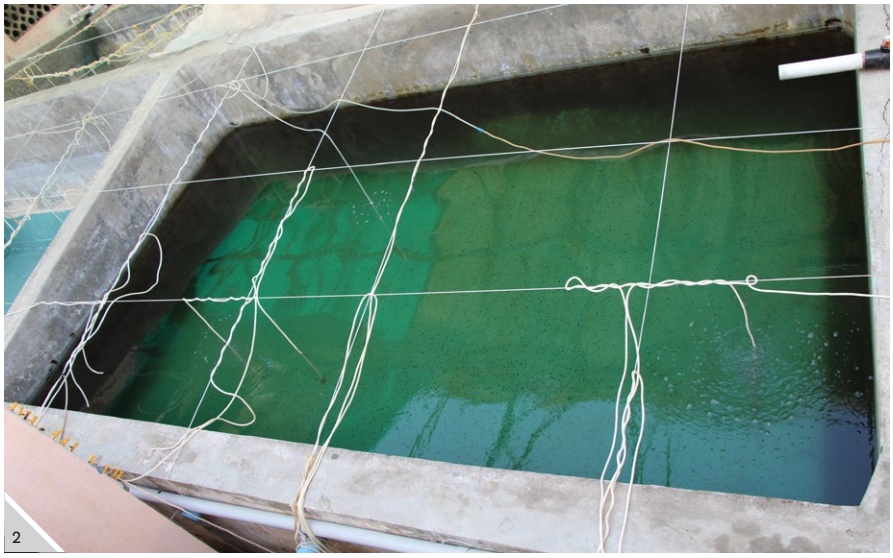
The first successful induced spawning of *Siganus vermiculatus* under controlled conditions was achieved with intramuscular injection of Human Chorionic Gonadotropin (hCG) at hatchery complex, Karwar RC of ICAR-CMFRI. Breeding pair consisting of female fish (31 cm, 750 g) with egg diameter above 400 microns and male fish (31.5cm, 800g) with thick oozing milt were introduced to hatchery after cannulation. These fishes were maintained in 3 ton FRP tanks and were fed with similar feeding regime as in cage. The breeding pair was intramuscularly injected with hCG at 16:00 hrs for 3 days during the first quarter of lunar cycle following a 24hr interval @ 500 IU and 200 IU for female and male respectively. As the eggs of siganus were demersal and adhesive in nature, fishes were released to nylon hapa in FRP tank after injection. Spawning was observed after 21 hrs and 30 minutes of the final dose of injection on 3rd day. The adhesive demersal spherical fertilized eggs (av. egg size: 560 µ) were found attached on the hapa. The nylon hapa with fertilized eggs were shifted to another 3 ton FRP tank filled with seawater of 28 ppt salinity and 27-29^{o}C temperature for embryonic development. The initial hatchlings were observed inside the nylon hapa after 25 hrs and 30 minutes of spawning. The newly hatched larvae measured 1.713 mm to 1.783 mm in size with yolk sac (420 µ) and oil globule (220 µ). Mouth opening (120 µ) was observed on 3 DPH. Larval rearing was done upto 8 day post hatching (8DPH) using pure cultures of marine microalgae, copepods and rotifers.

Indian Pompano *(Trachinotus mookalee)*

Hatchery production of Indian pompano was continued at Visakhapatnam centre of CMFRI. Since May, 2018 around

Details of induced spawning experiments carried out at hatchery complex, Karwar RC

Lunar period	Breeding pair		Remarks
	Female	Male	
January	575 g	550 g	No spawning response
February	700 g	650 g	No spawning response
March	750 g	800 g	Spawning, Hatching
	550 g	450 g	No spawning reasponse



1. Broodstock of *Siganus vermiculatus.*
2. Larval rearing of Indian pompano, *Trachinotus mookalee* in 10 t tank

80,000 advanced fry of 2 inch size has been produced. Farming experiments with hatchery Indian pompano seeds were being conducted at farmer's field and cages. The larval rearing of Indian pompano was carried out in 2 t and 10 t capacity tank. Larval rearing in 10 t tanks are found to be easier than rearing in 2 t capacity tank. Metamorphosis from larvae to fry started on the 17th day post-hatch and was completed by the 22nd day. After 30 days of rearing, the fry reached an average size of 2.5-2.9 cm in length and 1.1-1.3 g in weight with an enhanced average survival of 20%. The survival rate was increased considerably by doing nursery rearing in cement concrete tank of 10 tonnes capacity.

Sand whiting, *Sillago sihama*

About 2,500 broodstock is being developed under the project at Fisheries Research and Information Centre (Marine), KVAFSU, Bela Ankola. The brood stock under various size classes are being reared with formulated diets in earthen pond of 400 m^2 using tray feeding technique to attain 60 g size brooders. Once attaining 60 g size they are further reared to 80 g size in net cages and deployed for breeding.

Natural seed resources:

Natural seed resources along Kali estuary was carried out during the period 2018-19. Under prioritized species, *Caranx ignobilis* was found to be the most dominant species followed by *L. argentimaculatus* and *L. johnii*. However, the dominance varied between stations and also seasons. In Goa, survey carried out in two marine sites found that carangids and pomfrets were the most dominant species.

Wild finfish seed surveys were conducted in South and Middle Andaman in creeks of Burmanallah, Beodnabad, KodiyaGhat, Chidiyatapu, Carbyn beach, Guptapara, Mithakiri, Wandoor, Chouldhari, Sippighat, Dandus point and Ferargang using cast net (20 mm) and drag net (10 mm). Grey mullets *Liza* sp. dominated in all the sites followed by mud skipper, *Boleopthalmus* sp. The seeds of *Hemiramphus* sp., *Signaus* sp, *Ambassis* sp., *Therapon jarbua*, *Lutjanus johni*, *Epinephelus* sp., Oryza sp., *Elopsmachnata*, *Megalops cyprinoides* damsel fishes, eels, butterfly fishes, marine angel fishes, cardinal fishes, small gobies and blennies were collected and transported to the laboratory for identification. Length weight measurements for mullets were noted. In shell fishes, *Penaeus monodon, Metapenaus Monoceros, Macrobrachium* sp., Alphid shrimps and crabs were also collected. Seeds of molluscan species, *Tegillarca granosa, Arca* sp. and *Pinctada margaritifera* also observed in mangrove sediments and in pneumatophores. There is a huge potential for natural seed of mullet (Liza sp.) which constituted more than 80 % of the seed collections especially in creeks.

Availability of marine fish seed at Uttar Kannada from wild

Sl. no.	Fish Species	Jan	Feb	Mar	Apr	My	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Sillago sihama												
2	Etroplus suratensis												
3	Mullets Mugil species												
4	Pompano (Trachinotus Blochii)												
5	Snappers (Lutjanus sp.)												

The seed survey at NimtalaGhat, Jelepara and Banshtala of the coastal South 24 Parganas district was started from January 2019.

The Uttara Kannada District in Karnataka was composed of 5 no. of prioritized fish species such as *Sillago sihama*, Pompano (*Trachinotes blochi*), Mullets (*Mugil species*), *Lutjanus* sp. (Snappers) and *Etroplus suretansis*, while the Udupi District was composed of 4 no. of prioritized fish species like *Sillago sihama*, Mullets (Mugil species), *Lutjanus* sp. (Snappers) and *Etroplus suretansis*. The Dakhina Kannada district was represented by only 2 fish species like *Sillago sihama* and Mullets (Mugil species).

Summarizing all the available data a calendar of season wise fish seed availability along the Karnataka coast has been prepared

Farming demonstrations

Technology Demonstration

Under demonstration programme of marine cage culture, five cages, three circular 6m dia GI cages and 2 rectangular GI cages (48m3) were fabricated under AINP demonstration programme. Two fishermen Self Help Groups were identified in Baithkol and Karwar of North Kanara for marine cage culture. Two 6 m dia cages and one rectangular cage (4 x 4x 3 m) were installed in marine waters of Baithkol and stocked with 10 nos/m^3, 4 nos/ m^3 and 9 nos/m^3 of Asian sea bass, cobia and grouper respectively. Average growth of Asian sea bass, cobia and grouper were 450gm (150 DOC), 200gm (90 DOC) and 800 (120 DOC) gms respectively.

Experimental trials in Karwar Marine farm

One year study was made on the growth and survival of nursery reared Grouper, *Epinephleus coioides* in marine cage farm of Karwar RC. One thousand three hundred and fifty fishes with an initial weight of 30 g were stocked in 6 m dia GI cage and fed with pellet feed initially for three months and then with oil sardine @ 6% biomass till the end of the culture. Partial harvest of grouper was made at 365 days of culture with an average weight and biomass of 1.5 kg and 430 kg and with a revenue generation of Rs.1,19,215/-

Grow-out culture of Indian pompano in RAS

Indian pompano was nursery reared in cement tank fitted with RAS components at RC of CMFRI, Visakhapatnam. Series of 10 numbers of 10 tonne capacity tanks fitted with RAS components were used for grow-out culture. Indian pompano advanced fry of 6-7 cm were stocked at the rate of 45 nos/ m^3 and fed with artificial diet initially 8 % body weights and later decreased to 4-5%.

All India Network Project on Mariculture

1. Indian pompano harvested from recirculating aquaculture system

A total of 205 kg was harvested after 10 months of culture and during the period the fishes has grew from 6.5 g to 415 g.

Grow-out culture of Indian pompano in cage

The Indian pompano fry (2.5±0.02 g and 5.25± 0.04 cm in size) were stocked at 35 nos/m^3 in 6 m dia HDPE cages at Visakhapatnam. Initially fish has fed with pellet feed of 45% protein at 8-10% BW and then slowly shifted to 40% protein with 5-6% BW twice a day. The fishes have reached 280±0.5 g with pellet feed within six month of culture. Thereafter the fishes were stocked in to different cages in two different stocking densities (15 and 20/m3). Then fishes were reared for another six month with low value fishes. In the next six months of culture, fishes stocked at 15 and 20/m^3 reached to 769 and 478 g with FCR of 1:4.98 and 1:7.48, respectively. After 12 months of grow-out, the fishes have reached on an average 0.70 kg in weight.

Grow-out culture of Indian pompano in Pond

Grow out culture of Indian pompano in ponds was carried out with the technical support from RC of CMFRI, Visakhapatnam. At Bhavedevarapally, Krishna District, Andhra Pradesh, early fingerlings of the fish at 1.5 to 2.0 g in size were stocked in earthen shrimp pond. Single pond of 0.6 acre water spread area with 1.5 m water depth and 28-30 ppt water salinity was used for the culture. During nursery rearing in hapa the fishes were fed with feed containing 45% crude protein and 10% crude fat at 10-5% of BW for three months and fingerlings were reached 50g in size.

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Thereafter, after nine months the stocked fishes reached to 900g to 1250g with FCR of 1:1.75. After 14 months, the fishes were harvested and total of 850 kg fishes were sold at a price of Rs 335/kg.

Comparative growth performance of Indian pompano stocked in hapa and pond

Indian pompano have been cultured in grow out ponds at Bavadevarapalli village, Machilipatnam District. Initially, seed were stocked with 8,000 numbers, in which 4,000 seeds were directly stocked in pond and 4,000 seeds were stocked in the hapas in the same pond at a stocking density of 150 numbers per square meter. The fingerlings were stocked at 0.5 g in size and fed with pellet feed having 45% protein at 18-5% BW. Advanced fry were stocked at 0.5 g in size and after three months of rearing the fishes stocked in hapa reached an average size of 55.5g and fish stocked in pond reached a size of 24.18g.

Cage culture Demonstrations in Kerala

GI floating cages of 4x4m size were installed in Chemmakkad, Ashtamudi and Chavara areas of Kollam. Total 6 cages were installed and were stocked with pompano seeds both silver pompano *Trachinotus blochii* and mangrove red snapper *Lutjanus argentimaculatus*. Size at stocking was 10g. Snappers attained a growth of 300-550g and pompanos 200-300g in 6 months trial.

Orange spotted grouper, *Epinephelus coioides* farming has been successfully conducted at Kollam, (Prakkulam and Chemmakkad) Kerala. Six cages were stocked with juveniles of size 11.5cm @ 10nos/ m^3. Fish were grown to an average size of 1.25kg in a 10 months culture where only low value fish was used for feeding. Average growth was only 0.95kg where both pellet and low value fishes were used. Uniform growth was observed in low value fish fed group only. The result of the study has been presented in 6th International Symposium on Cage Aquaculture in Asia 2018 (CAA6) at Surat Thani, Thailand

GI floating cages of size 4x4m square and 6m diameter round cage were installed in Prakkulam. The cages were stocked with Indian pompano *T. mookalee* seeds brought from Visakhapatnam centre of CMFRI. Size at stocking was 10g. Fish reached 300-

Indian pompano growth performance in pond and pond based hapa

Days	Hapa	Pond
	Weight(g)	Weight(g)
0	0.5	0.5
20	3.8	0.5
40	08.45	1.5
55	18.45	05.25
60	34.8	09.45
75	43.86	15.25
90	55.85	24.18

1. Harvested Indian pompano, *Trachinotus mookalee* from cage
2. Cage culture at kerala
3. Cage culture at Morthota Andhra Pradesh
4. Marine cages installed at Jaigad
5. Nursery rearing of *Siganus*

450g in 6 months farming trial.

Open sea cage culture

Circular 6m dia cages were installed in open sea at Jaigad with the help of JSW port in month of February. One cage is being used to culture *Siganus vermiculatus* for broodstock development and second cage is for demonstrating farming of marine finfishes in cages.

Cage culture at Morthota, Andhra Pradesh

3 square cages of 6x6m and one 6 m dia cage were installed at Morthota, AP. The wild collected *Lates calcarifer* seeds were stocked in hapas fixed in the cages. Seabass seed of average weight of 31.3gwere stocked in cage I and 11.29g weight fishes were stocked in cage II.

Fish were fed with floating feed as well as fresh fish cut into required size pieces. Growth was recorded at regular intervals of 30 days. Water quality parameters like D.O, pH, Salinity, ammonia, nitrate and nitrite were analyzed at fortnightly intervals, and body weight monitored at monthly intervals. Fish in cage I has grown to 54.5±0.28 and 18.29±0.25 in cage II. Few fishes recorded high growth; the weights were 150g, 250g, and 440 g.

Cage culture in 6 and 8 m dia Cages in Suryalanka, Bapatla

Pompano and milkfish were cultured in n both 4m dia, 6m dia and 8 m dia cages. Growth was recorded at regular intervals of 30 days. Water quality parameters like D.O, pH, Salinity, ammonia, nitrate and nitrite were analyzed at fortnightly


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intervals, and body weight monitored at monthly intervals.

Site selection studies

Karwar

A survey was made along North Kanara and Udupi districts for the selection of suitable sites for marine cage farming. In Karnataka, a total of 16 sites including 13 sites from North Kanara and 3 from Udupi districts were identified as suitable for farming. In Goa, total of 22 sites were surveyed and 4 sites were found suitable for undertaking the cage faming.

Andaman

Site selection studies for cage culture were initiated in South Andaman district in North Bay, New Wandoor, Rutland, Sippighat, Minnie Bay, Port Mout collecting parameters such as depth, transparency, temperature and salinity. Details of the sites surveyed were given in. The sites at North Bay and North Wandoor were found to be more protected and conducive for cage culture. As site selection studies were recently initiated, still more areas are to be covered in future to at arrive at a consolidated decision on sites that were found to be suitable for cage culture.

The site selection studies were conducted in collaboration with self help group named Andaman marine products developed by ICAR-CIARI based on skill development trainings. The cages to be installed will be managed through community participation of fishermen SHG's.

Kerala Coast

Based on the preliminary information and suggestions from Department of fisheries, Govt of Kerala, the following five areas were identified for undertaking GIS based studies and a digital database was developed by RC of CMFRI, Mandapam using the GIS platform to earmark suitable locations for sea cage farming.

- Off the coast of Ezhimala Naval base
- Vellyamkallu – in Koilandy
- North West direction of LNG terminal (Puthuveypu) Ernakulam (Non Fishing Zone)
- Thirumullavaram (Kollam)
- Off the coast of Adimalathura – (Trivandrum)

Bathymetry data were obtained from the

1. Locations for suitability studies conducted in South Andaman for cage culture
2. Site selection studies in progress in collaboration with SHG's

Average Growth (length and weight) of Pompano reared in cages at Suryalanka, AP

Month	Weight(g)	Length(cm)
April	11.4	8.8
May	26.5	10.5
June	42.3	12.1
July	91.4	15.4
August	122.3	17.2
September	150.8	19.3
October	171.3	22.4
November	197.5	24.1
December	250.3	26.8
January	310.7	28.4
February	366.3	29.4
March	420.1	31.2

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Naval Hydrographic Charts prepared by National Hydrographic office, Dehradun and the data on landward side facilities were obtained from the Toposheets prepared by Survey of India. The available data have been put on the GIS platform and a GIS map has been created. Additional information from the CMFRI Marine Census data (fishing villages, fish processing plants, ice plants, cold storages etc.) will be incorporated to improve the efficacy of the map.

The spatial criteria followed in the selection of coastal villages were:

A. Depth: 5 to 15 m
B. Distance from shore: Up to 1.0 km, preferably within 0.5 km
C. Access to arterial roads and markets

Policy brief – CIARI- CMFRI-NIOT- A&N Administration

Few entrepreneurs keen on taking up cage culture activities in the islands have already initiated the activities on procuring the cages through financial support, however the auxiliary support to undertake cage culture with adequate requirement needs to be resolved with collaboration of stakeholders. Lack of a proper policy directive was found to be a major issue for the promotion of open sea cage culture activity and hence ICAR-CIARI under AINP mariculture programme took lead initiative in preparation of a policy brief involving Department of Fisheries, A& N Administration and other scientific organizations. The policy brief was well received by the administration and was appreciated for being a first policy note on fisheries sector in the Islands.

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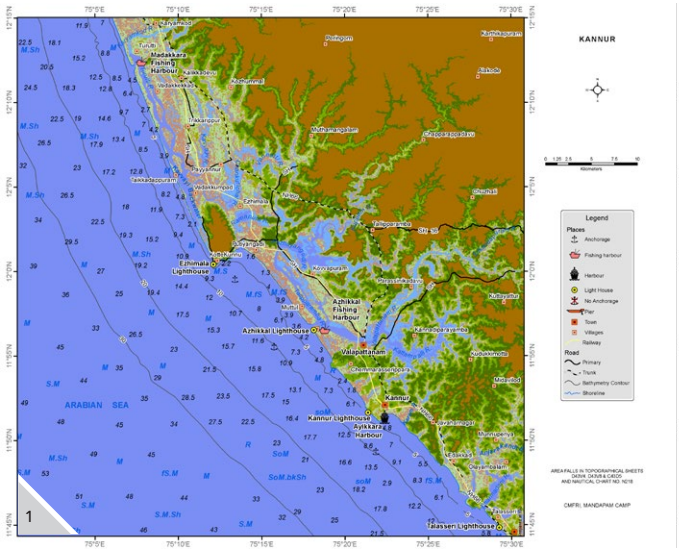

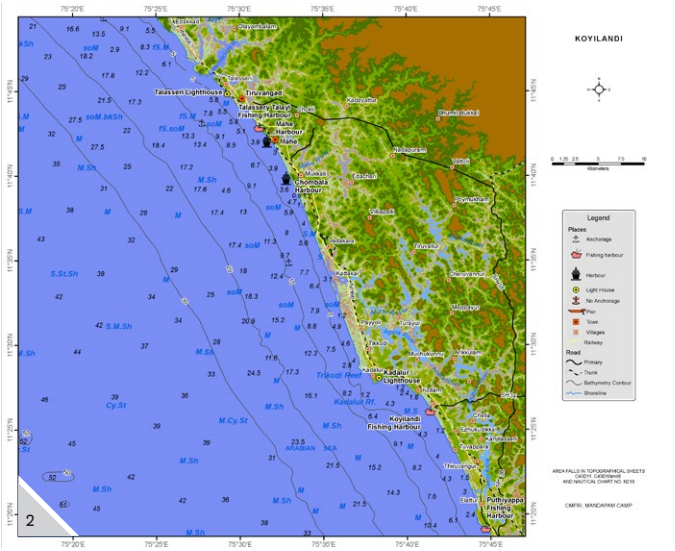

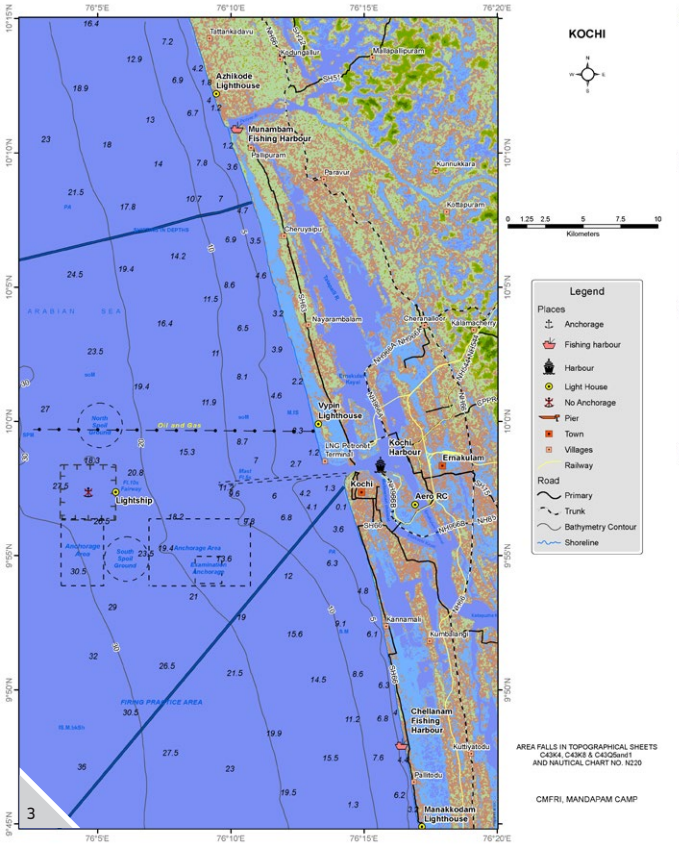

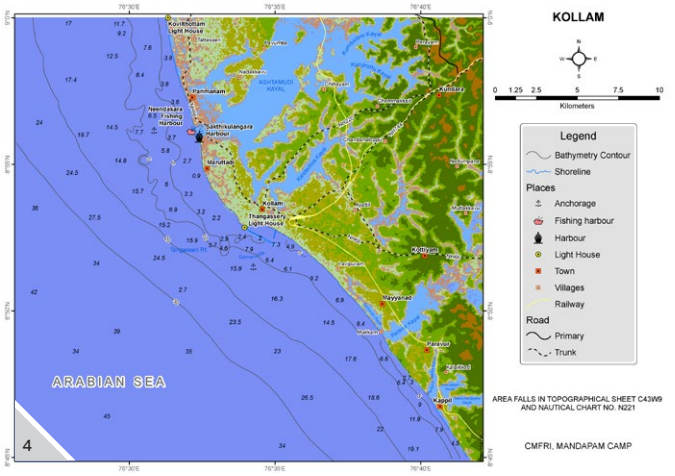

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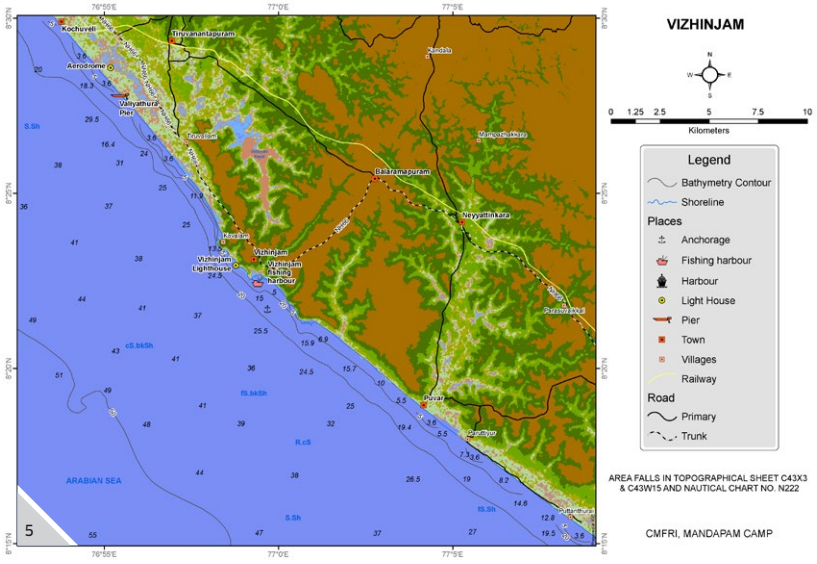
1. Kannur (Off the coast of Ezhimala Naval base)
2. Vellyamkallu – in Koilandy
3. North West direction of LNG terminal (Puthuveypu) Ernakulam (No Fishing Zone)
4. Thirumullavaram (Kollam)
5. Off the coast of Adimalathura – (Vizhinjam, Trivandrum)
6. Participants of training programme fabricating a floatng cage.



Training programmes

Organized four training programmes for students, scholars and fishermen under AINP during April 2018- March 2019 at Karwar centre of CMFRI. All the participants were given hands-on training in cage fabrication, site and species selection, culture protocols, net exchange, harvesting and marketing.

Skill development training for 3 days from 25.02.19 to 27.02.19. on sea cage fish farming was organized under the AINP (M) project in collaboration with FRIC (M), Ankola. 30 farmers were benefitted from the training. Various topics on fish farming in sea cages were discussed in the training like design and fabrication of net cages, anchoring and installation of cages, different types of nets used, fish species suitable for net cage farming, feeds, feeding and economics of cage fish farming.

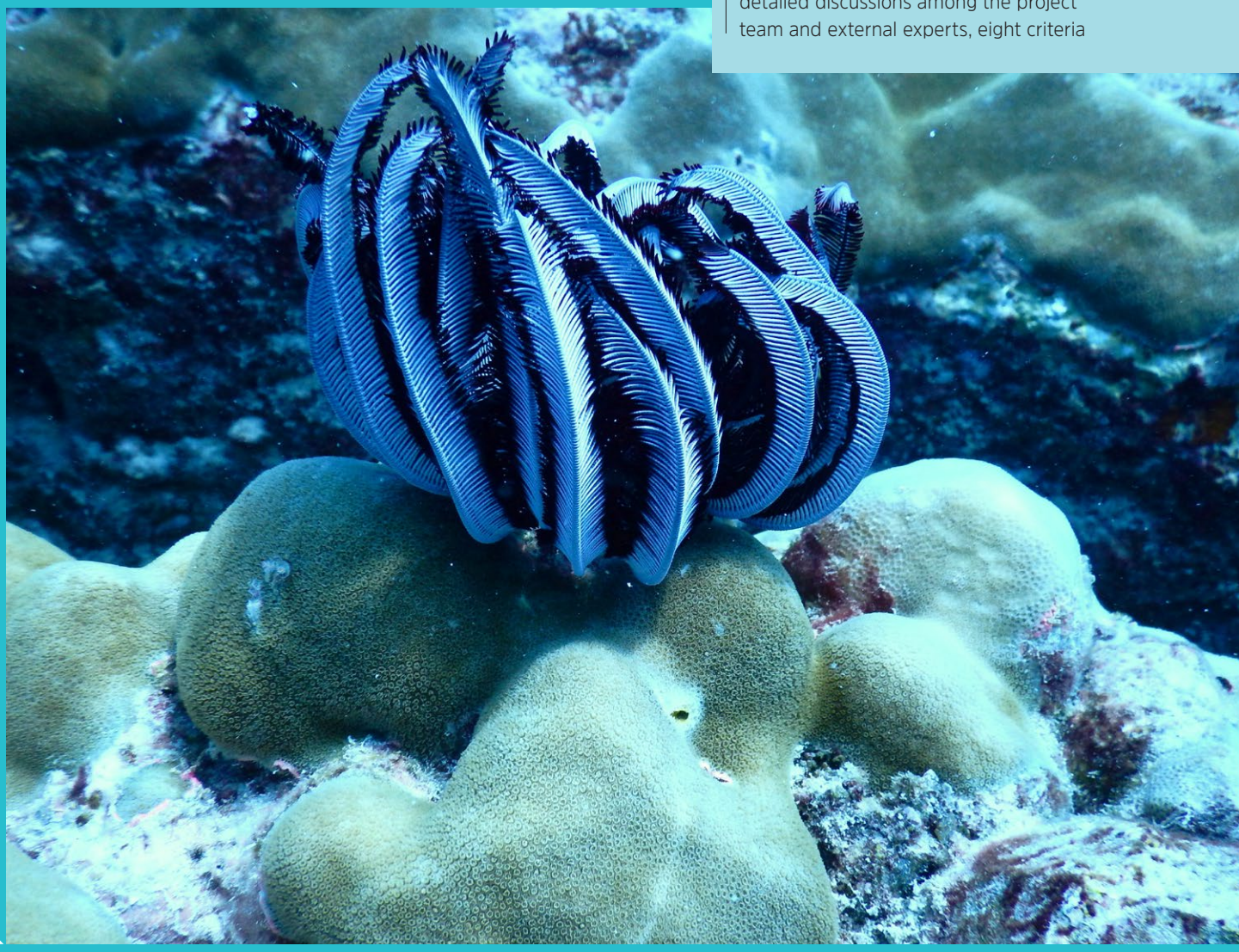
Marine Biodiversity

Conservation of Biologically Sensitive Areas

Developing conservation plan for biologically sensitive areas along the Indian coast

Reearch Project: MBD/CNS/30

A total of 12 criteria (5 criteria in addition to the 7 EBSA criteria of CBD) and 34 indicators were identified during the first project workshop held in June 2017. After detailed discussions among the project team and external experts, eight criteria



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and 20 sub-criteria were finalised during the second workshop, for identification of biologically sensitive areas along the Indian coast. During the reporting period, 26 locations were selected along the Indian coast, for detailed studies.

Gujarat coast

The coastline of Gujarat divided into three zones *viz*., Zone 1: Lakhpat to Okha; Zone 2: Okha to Gopnath and Zone 3: Gopnath to Umergaon. Zone 1 is characterized by the presence of coral reefs, seagrass beds and mangroves and therefore rich in biological diversity. Zone 2 is significant due to the presence of whale sharks, turtles and congregation of birds. Zone 3 is known for mud flats and mangroves.

Maharashtra coast

Along the Maharashtra coast, Thane creek, Vasai creek and Devbhag coast were studied. Thane creek assumes importance for mangrove restoration and declaration of a flamingo sanctuary. The decline in mangrove forests and pollution is characteristic of Vasai creek while the Devbhag coast has patchy corals reefs, mangroves and also well known for eco-tourism.

Karnataka coast

Karwar and nearshore islands and Netrani Island were extensively studied along the Karnataka coast. Karwar region is known for its rich diversity of ecosystems as well as species, while the Netrani Island is known for patchy

Criteria and sub-criteria for identification of biologically sensitive areas

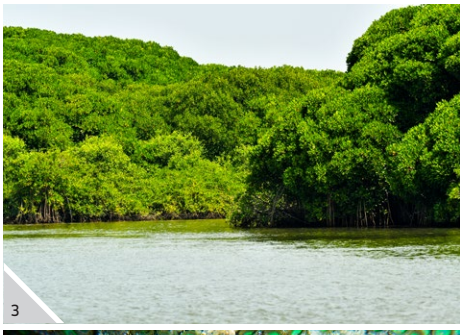
Sl. No.	Criteria	Sl. No.	Sub-criteria
C.1.	Uniqueness and rarity	C.1.1.	Species
		C.1.2.	Habitat/Ecosystem
		C.1.3.	Physical features
C.2.	Special importance for life-history stages of species	C.2.1.	Spawning and nursery grounds
		C.2.2.	Spawning/Nesting aggregation
		C.2.3.	Feeding aggregation
C.3.	Importance for threatened, endangered or declining species and / or habitats	C.3.1.	Occurrence of species
		C.3.2.	Assemblage of species identified under C.3.1.
C.4.	Vulnerability, fragility, sensitivity and slow recovery	C.4.1.	Presence of sensitive/critical habitats
		C.4.2.	Proportion of sensitive/critical habitats
		C.4.3.	Occurrence of vulnerable species
C.5.	Biological productivity	C.5.1.	Primary productivity
C.6.	Biological diversity	C.6.1.	Diversity of ecosystems
		C.6.2.	Diversity of species
C.7.	Naturalness	C.7.1.	Level of human interference
		C.7.2.	Natural degradation
C.8.	Ecosystem functions	C.8.1.	Provisioning services
		C.8.2.	Regulating services
		C.8.3.	Supporting services
		C.8.4.	Cultural services

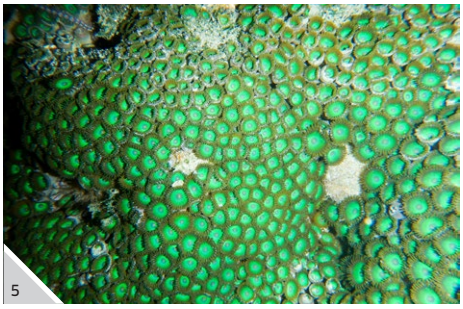
1. Sea lilly at Kavaratti
2. A view of Netrani Island

coral reefs and rich avian fauna of over 300 species. The Indian Swiftlets which are protected under the Schedule I of the Indian Wildlife (Protection) Act, 1972 are known to breed in the caves of Netrani Island.

Kerala coast

Along the Kerala coast, Kadalundi and Thikkodi (Calicut District); Chettuva estuary and nearshore waters of Blangad (Thrissur District); Puthuvype, Mangalavanam and adjoining Cochin backwaters and wetlands (Ernakulam District); Thottapally-Trikkunapuzha beach and nearshore regions from Punnapra to Thottapally (Alappuzha District); Panathura to Vizhinjam bay, Poovar-Pozhiyur (Thiruvananthapuram District) were extensively studied.





1. Parrot fish and associated fauna at Netrani
2. Indian Swiftlet breeding ground at Netrani Island
3. Chettuva estuary
4. Birds at Kadalundi
5. A colony of Zoanthids of Thikkody
6. *Caulerpa* sp. at Thikkody

Candidate areas assessed against each of the criterion and sub-criterion (provisional)

Candidate areas	C1			C2			C3		C4			C5	C6		C7		C8			
	C1.1	C1.2	C1.3	C2.1	C2.2	C2.3	C3.1	C3.2	C4.1	C4.2	C4.3	C5.1	C6.1	C6.2	C7.1	C7.2	C8.1	C8.2	C8.3	C8.4
Gurarat																				
Zone 1: Lakhpat to Okha	M	H	H	M	H	L	M	L	H	H	M	H	H	H	H	H	M	M	M	M
Zone 2: Okha to Gopnath	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	L	L	L
Zone 3: Gopnath to Umergaon	N	M	M	L	L	L	L	L	L	L	L	M	L	M	H	H	L	M	L	L
Maharashtra																				
Thane creek	H	L	L	H	H	H	L	L	H	H	L	H	M	M	M	H	H	H	H	H
Vasai creek	L	L	L	M	M	M	L	L	L	L	L	H	M	M	L	H	H	H	M	M
Devbhag coast	L	H	L	H	H	H	H	H	H	M	H	H	H	H	H	H	H	H	L	H
Karnataka																				
Karwar and nearshore Islands	M	N	H	H	H	H	H	H	H	H	M	H	H	H	H	N	H	H	H	H
Netrani Island	H	N	H	H	H	H	H	H	H	H	H	M	H	H	H	H	H	L	N	H
Kerala																				
Kadalundi	N	N	N	H	H	H	H	H	H	H	H	H	H	H	L	L	H	H	H	H
Thikkodi	N	N	N	H	L	M	H	H	H	H	H	H	M	H	H	L	H	H	M	M
Chettuva estuary and nearshore waters of Blangad	N	L	L	M	M	M	H	M	H	L	M	NI	M	H	L	L	M	H	M	H
Puthuvype, Mangalavanam and adjoining Cochin backwaters and wetlands	N	M	M	H	H	H	H	H	H	H	H	H	H	H	H	M	H	H	H	H
Thottapally-Trikkunapuzha beach and nearshore regions from Punnapra to Thottapally	N	H	H	H	L	H	M	L	H	H	H	H	M	M	L	M	H	NI	N	L
Panathura-Vizhinjam	H	H	H	H	H	H	H	H	H	L	M	H	H	H	M	M	H	H	H	H
Poovar-Pozhiyur	M	M	N	M	L	L	L	L	H	H	H	L	H	H	L	N	H	H	H	H
Tamil Nadu																				
Gulf of Mannar	H	H	H	H	H	H	H	M	H	H	H	H	H	H	H	H	H	H	H	M
Muthupettai lagoon	N	H	H	H	H	H	H	H	H	H	M	H	M	M	H	M	H	H	H	H
Udayamarthandapuram	N	H	M	H	H	H	M	M	H	H	M	H	L	L	H	M	L	L	L	H
Greater Vedaranyam swamp	N	H	H	H	H	H	M	M	M	M	M	H	L	L	H	M	L	M	H	H
Point Calimere	H	H	M	H	H	H	H	H	M	H	M	M	M	H	H	M	L	M	L	H
Andhra Pradesh																				
Bangarammapalem	L	L	L	H	L	L	M	L	L	M	H	L	H	M	L	L	H	H	L	L
Pudimadaka	L	L	L	L	L	H	H	L	L	L	H	L	M	H	M	M	H	M	L	L
Bhairavapalem	L	L	L	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H	L	L
Chollangi	L	L	L	H	H	H	H	L	H	M	H	L	H	M	H	H	H	M	L	L
Hamsalladevi	L	L	L	H	H	M	H	H	H	H	L	L	H	H	H	H	H	H	L	L
Bantumalli	L	L	L	L	L	L	L	L	L	L	L	L	M	M	M	M	M	M	L	L

Index:

No Information (NI)	Nil (N)	Low (L)	Medium (M)	High (H)

Tamil Nadu coast

The Gulf of Mannar ecosystem was extensively studied. Besides, the Muthupettai lagoon, Udayamarthandapuram bird sanctuary, Greater Vedaranyam swamp and Point Calimere which are rich in diverse ecosystems and species were also covered.

Andhra Pradesh coast

Bangarammapalem and Pudimadaka in Visakhapatnam District, Bhairavapalem and Chollangi in East Godavari District, and Hamsalladevi and Bantumalli in Krishna District were studied in detail.

The assessment of candidate areas assessed against each of the criterion and sub-criterion is presented. in. The assessment is provisional and would be finalized after thorough review of the templates that are under preparation for each candidate site.

Investigations on the scyphozoan and cubozoan jellyfish diversity and distribution along the Indian coasts

Research project: MBD/JLY/32

Surveys along the Indian coast starting from Gujarat (5 centers), Maharashtra (7 centers), Karnataka & Goa (2 centers), Kerala (11 centers), Tamil Nadu (15 centers) and Andhra Pradesh (8 centers) were carried out during the period from April 2018 – February 2019 and the swarming of different species of jellyfishes were recorded.

Altogether there were 15 species of jellyfishes recorded during this period along the coastal waters of India belonging to 10 families and 14 genera, of which nearly 12 species were found to be swarming in nature. *Chrysaora* sp. was the dominant species found in all the coastal waters of India and the order of abundance as follows;

Chrysaora sp. >Cyanea sp.>Rhopilema sp.> Lobonemoides sp.>Lychnorhiza sp.> Acromitus sp.

Four species support Indian Jellyfish fishery along the coast of Gujarat and Andhra Pradesh and an estimated 50 crores worth of fishery is taking place during the peak swarming seasons along the coasts of these two states.

The general swarming seasons of Jellyfishes along the coastal waters has been observed to be

East Coast: Post monsoon swarming–Major (Mar-June)
Pre monsoon swarming–Minor (Sep-Oct)

West Coast -Kerala: Pre monsoon swarming–Major (Mar-May)
Post monsoon swarming – Minor (Sep-Oct)

West Coast–Karnataka, Goa, Maharahstra and Gujarat : (Sep-Jan) (Apr-May)

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Marine Biodiversity

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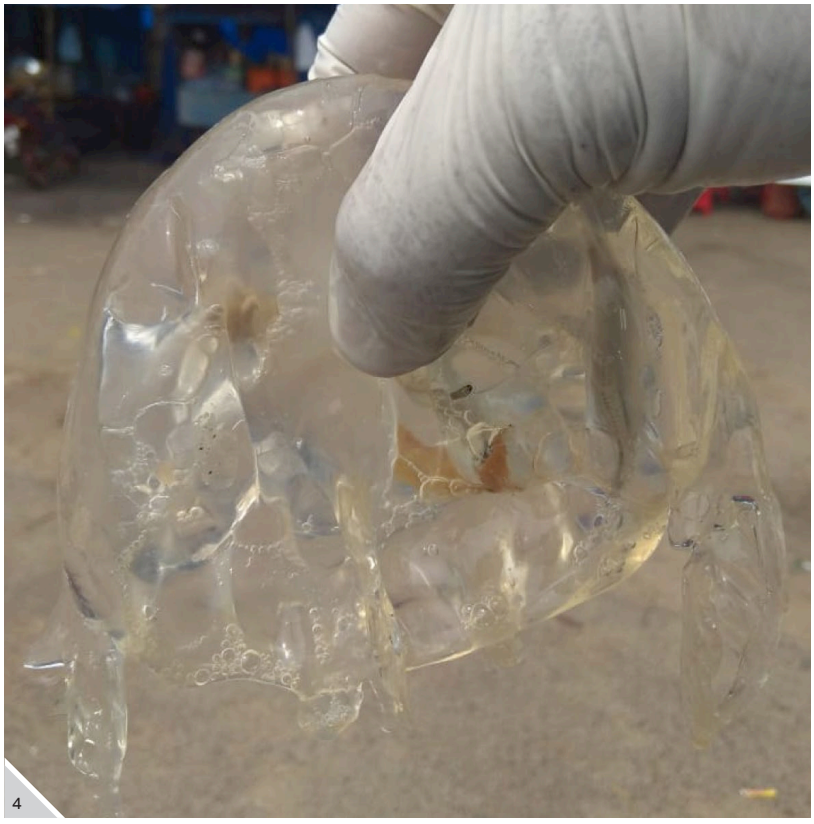

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1. Release of Jellyfish brochure at Mandapam by Dr. J. Jena, DDG, Fishereis, Dr.A.Gopalakrishnan, Director CMFRI.
2. Demostration of Jellyfish first aid kit at Mandapam
3. *Chrysaora* sp.
4. *Chiropsoides* sp.
5. Jellyfish observation at Mandapam
6. Installation of Jellyfish management advisories at Mandapam

The present project further confirms that the distribution of *Crambionella annandalei* along Indian coastal waters.

JellySafe first aid kit was released on the occasion of 72nd Foundation day at Mandapam Regional Centre of CMFRI on 5th February 2019. JellySafe First aid kit usage demonstration at Ariyaman Beach for tourists and for Dhanuskodi fishermen has been conducted. Jellyfish sting management advisory board has been set up in two places viz., Arichalmunai and Ariyaman Beach.

Coral reef ecosystem

Assessment of resilience potential of coral reefs

Research Project: MBD/CRL/31

Underwater survey was conducted in the reef flats and fore reefs of Agatti atoll during 18 to 24 April 2018. Data on the benthic functional groups and coral diversity were collected from 9 stations. Survey was made at the reef flats and fore reefs of Amini atoll during 07 to 09 May 2018. Coral bleaching, impact of Ockhi and prevalence of coral diseases were estimated during the survey. 17 stations inside and outside the lagoon of Kavaratti atoll were covered during an


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1. Polyps of Mushroom coral at Agatti
2. *Acropora colony with moorish idol fish at Agatti*
3. *Galaxea fascicularis at Kavaratti*
4. *Polyps of Goniopora coral at Kavaratti*
5. *Coral associated fauna at Kavaratti*
6. *Staghorn coral at Kavaratti*
7. *Brown Noddy at Pitti Island*
8. *Cabbage coral from Netrani Island*
9. *Morray eel at Nethrani Island*

underwater expedition during 14 to 24 February 2019. Coral resilience indicators and various stressors and threats to the coral biodiversity were recorded and are under analysis. Habitat modelling of coral reefs along the Lakshadweep Chagos Archipelago was performed to identify the hitherto unknown distribution of coral reefs in the area. Maximum Entropy model was used for the distribution modelling. Several submerged banks were showing higher probability to have coral reef existence. Species distribution modeling of the Acroporid reefs were performed to identify their distribution in the remote locations of the Andaman – Nicobar and Mergui Archipleago in the Andaman Sea.

Coral larval dispersal and connectivity among the atolls of Lakshadweep – Chagos were studied. The numerical simulation modelling was performed based on the HYCOM current data. Simulation model gave light on the atolls which acts as the sources and sinks of the coral larvae and this information is vital for the resilience estimation. Underwater survey was carried out during January 2019 to understand the present status of patchy reef in Vizhinjam and Enayam. *Pocillipora verrucosa* and *P. damicornis* was observed to be the dominant species at Vizhinjam. *Montipora* spp shown to have a high recruitment during the period of survey. Eight hard coral species were recorded from Enayam including a new dendrophyllid coral. Dominant coral fishes were from the family Pomacanthidae, Pomacentridae, Acanthuridae, Siganidae and Mullidae.

Reefs at the Devgad coast of Malvan, Sindhudurg has been surveyed and the results indicates a moderately healthy status of these reefs. Some of the major stressors identified were damage due to anchorage, zoanthid infestation, coral bleaching and coral diseases. Preliminary surveys were also

conducted at Andaman Islands, and Patchy reefs off Karnataka to make a scoping study on the extent of the resilience indicators and stressors in the region.

The study along the Gulf of Kutch, Gujarat highlights the survey information collected through the six surveys each at the nine stations for the anthropogenic stressors on the coral reef ecosystem. The ranking of most detrimental impact by the anthropogenic stressors on coral reefs along the Gulf of Kutch and their nature and magnitude of impact were documented.

A preliminary survey of Coral reef sites was carried out in the Andaman Islands during 5-11 October 2018. Two sites in Havelock Island, Elephant Beach and Havelock and one site in Wandoor in Port Blair were surveyed and documented through underwater photography and videography. High degree of coral species diversity along with coral reef fishes, sea urchins, holothurians, gastropods and giant clams were recorded. The corals identified tentatively from underwater images are *Acropora aspera, A. muricata, A. grandis, A. abratanoides, A. millepora, A. florida, A. tenuis, A. gemmifera, A. humilis, A. nasuta, A. nobilis, A. valenciennsi, A. lamarcki, A. polystoma, Ctenactis echinate, Fungia* sp. , *Diploastraea heliopore, Dipsastraea pallida, Dipsastraea* sp., *Favites halicora, Goniastrea edwardsi, Goniastrea* sp., *Coelastrea aspera, Leptastrea* sp., *Psammacora contigua, Psammacora obtusangula, Porites lutea, P. lobata, P. murrayensis, P. monticulosa, P. rus, Porites* sp., *Lobophyllia sp.*

Molecular taxonomy and phylogeny of Cones and strombs of the Indian coast

Research Project EF11

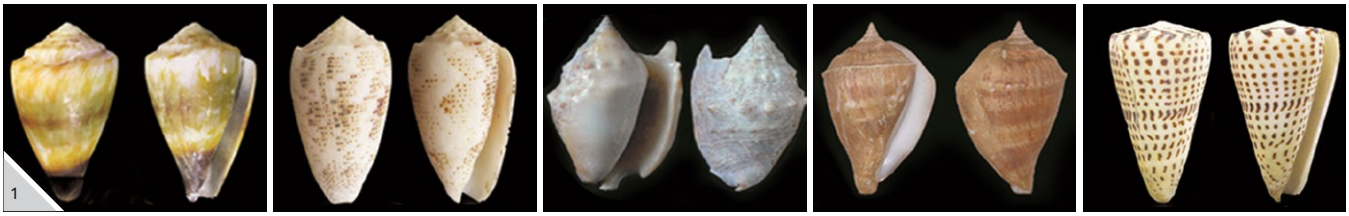
In total, 45 individuals from 15 species of the families Conidae (12) and Strombidae (3) were collected from six sites along the Andaman Nicobar Islands (South Andaman- Bermenella, Wandoor, Havelock, Middle Andaman- Mayabandhar, North Andaman- Diglipur, Areal bay.) and Mandapam, Gulf of Mannar and Cuddlore region of south east coast of India. Specimens were identified based on shell morphology; morphometric and meristic data. Fragments of the mitochondrial genes 12S rRNA, 16S rRNA, Cytochrome oxidase subunit I (COI) and nuclear H3 gene were amplified. PCR amplification and sequencing of 45 individuals from 15 species of the families Conidae and Strombidae for all the four genes as mentioned above have been completed.

FIMSUL II

Fisheries Implementation of world bank assisted CDRRP-FIMSUL II (Tamil Nadu Fisheries Department) Estimation of marine fish landings in Tamil Nadu with enhanced sampling coverage

A two days review workshop on 4th -5th July 2018 was conducted under FIMSUL II – Component III project for the staff of the Fisheries department of Tamil Nadu.

A mobile APP namely ËNMEEN was developed to facilitate on line data collection and data transmission by external clock mechanism to ensure that both the sender and receiver are synchronized with each other.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Bivalve farming

Bivalve farming under the Fisheries Management and Sustainable Livelihood Project (FIMSUL – II, Component – II) was undertaken in three fishing villages viz; Cuddalore, Kottaikadu and Palavercadu in Tamil Nadu with technical guidance from CMFRI, for setting up bivalve farms.

Beneficiaries selected from the respective villages were trained to prepare oyster rens and installation of rafts. The first partial harvest of bivalves – green mussels & oysters was done at Pazhaverkadu on 29.11.2018 in the presence of Dr. G.S. Sameeran, I.A.S, Director of Fisheries, Government of Tamil Nadu.

Valuation of marine and coastal ecosystem in Kadalundi Community Reserve of Kerala

Research Project EF19

Developed detailed catalogue of ecological services and estimated values of Ecological services provided by different services like Provisional, Regulating, Supporting and Recreation of KVCR. A total of eight species of mangroves *viz*., *Avicennia officinalis*, *A.marina*, *Rhizophora mucronata*, *Sonneratia alba*, *Bruguiera sexangula*, *B. cylindrica*, *Excoecaria agallocha* and *Acanthus ilicifolius* which belonged to 6 genera and 5 families were recorded from the Kadalundi mangrove wetland.

Halophila beccarii Ascherson, 1871 (Ocean Turf Grass) listed in the IUCN Red List – VU was recorded from KVCR.

A total of 63 species of avian fauna were recorded from the Kadalundi-Vallikunnu Community Reserve. Of these, 40 are resident species and the rest migratory.

The bench mark survey to assess the socio economic status of the stakeholders in the community reserve was completed. The preliminary analysis of the bench mark survey indicated that 96 per cent

1. Conus species collections
2. Bivalve harvest at Pazhaverkadu by Dr. G.S. Sameeran, I.A.S, Director of Fisheries, Government of Tamil Nadu
3. A view of the Balathurut island of KVCR
4. Flowering of *Avicinnia officinalis* at Kadalundy of KVCR


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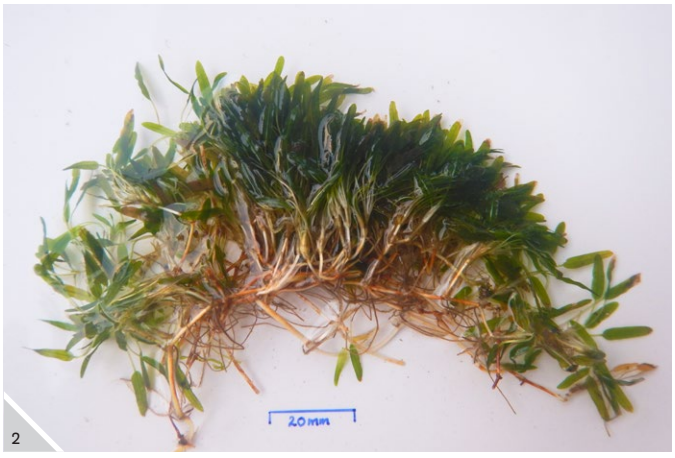

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of the respondents were working on an occupation other than fishing and four per cent was involved in fishing. Two fishing groups at KVCR employs Trap fishing (Thada) for about 144 days. A project Inception Meeting was organized at the Calicut Research Centre on 26th April, 2018. A stakeholder Consultation Workshop was organised on the 27th of August, 2018 at the Kadalundi-Vallikunnu Community Reserve (KVCR) in which 86 stakeholders participated.

A stakeholder Consultation Workshop was organised on the 27th of August, 2018 at the Kadalundi-Vallikunnu Community Reserve (KVCR) in which 86 stakeholders participated.

1. *Rhizopora* sp at Kadalundy of KVCR
2. *Halophila beccari* at Kadalundy of KVCR
3. Great Egret, *Ardea alba* at Kadalundy of KVCR
4. Black headed gulls and brown headed gulls at Kadalundy of KVCR
5. Trap fishing (Tada) at Kadalundy of KVCR
6. *Fasciospongia* sp. from Tuticorin
7. *Phyllospongia* sp. from Manapad
8. *Clathria* sp. from Alanthalai
9. *Cliona celata* form Trippalakudi
10. Demospongia (*Haliclona* sp.) from GOM
11. Demospongia from Kayalpatnam

Taxonomical Investigation on Lesser Known Marine Animals of India-Phylum: Cnidaria (Class: Anthozoa) and Phylum: Porifera (Marine)

Survey and inventorisation of sponge resources was done from Mandapam (25), Tuticorin (12), Kovalam (41), Vizhinjam (29), Muttom (100), Panathura (6), Perumalathura (24), Vizhinjam Hatchery (8) and Kovalam light house (16). A total of 41 major Surveys (29 days) and 13 minor Surveys (13 days) were conducted during the year for the collection of Sea Anemones and Sponges. Three Underwater surveys at Vizhinjam and two underwater surveys at Gulf of Mannar were conducted. Different species of sponges were collected from the centres.

Preparation of spicules from 395 Sponge samples was completed. Studies on spicule morphology and structural details using light microscopy is in progress. A Project inception workshop on the methodology of sponge collection and analysis was organized on 17.09. 2018. Identification of 50 specimens of Sponges were completed.


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Marine Habitats

Marine macrophytes in India- Resource dynamics and ecosystem services

Research Project: (FEM/ MPH/29)

Production from farming of seaweed *Kappaphycus alvarezii* along south east coast of India during 2018 was estimated as 350 tonnes dry weight, about five times higher than previous year.

Exploitation of wild seaweeds for agar and algin extraction, manure and bioactive molecules from the south east coast of

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India during 2018 was 3540 tonnes dry weight, indicating a decline of 14% over that of 2017.

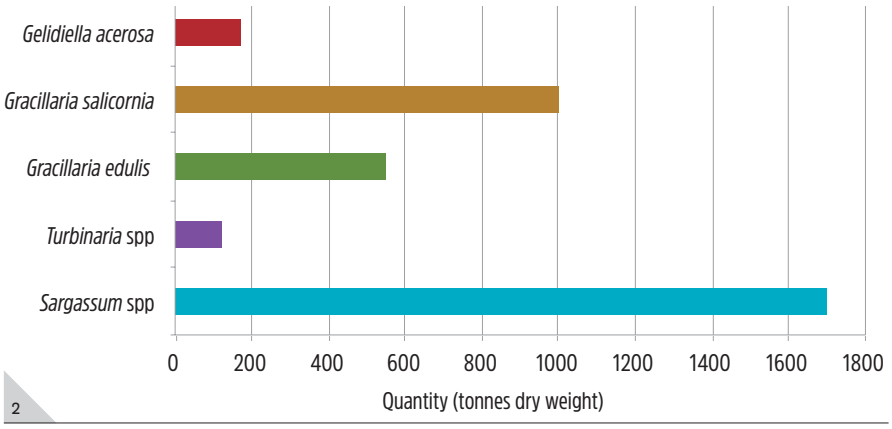
MSY of seaweeds exploited from Indian coast was estimated as 17775 tones wet weight/year.

Extensive survey conducted along Pulikat Lake indicated the occurrence of dense meadows of three sea grass species *viz., Halophila stipulacea, H. beccarii* and *Halodule pinnifolia*. Primary productivity studies indicated that the southern side of the Lake was heterotrophic, while the mid and northern parts were highly autotrophic, which is supported by high levels of dissolved nutrients.

Sea grass dependent fishery resources were identified from Pamban to Valinokkam coast through underwater surveys. Different types of fishery and the major resources were recorded.

In Gujarat sea grass diversity along Bhural and Sikka reef of Gulf of Kutch was studied and four species of sea grass, *Halodule uninervis, Halophila ovalis*, *Thalassia hermprichii* and *Halophila beccari* were observed. High rate of sedimentation due to harbour and jetty developments and industrial waste along the areas was found to harm the sea grass beds.

Sea grass transplantation experiments using *Cymodocea serrulata* and *Syringodium isoetifolium* conducted at Chinnapalam and Soliakudi coasts using PVC rafts of 1x1m size gave encouraging results.



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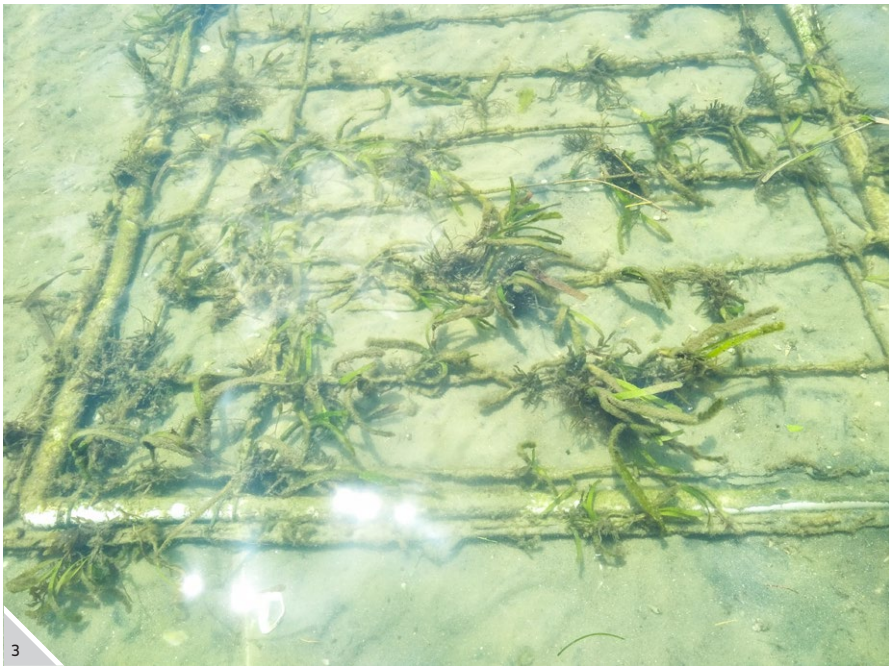
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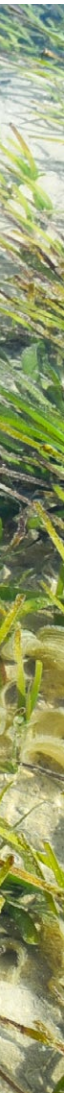


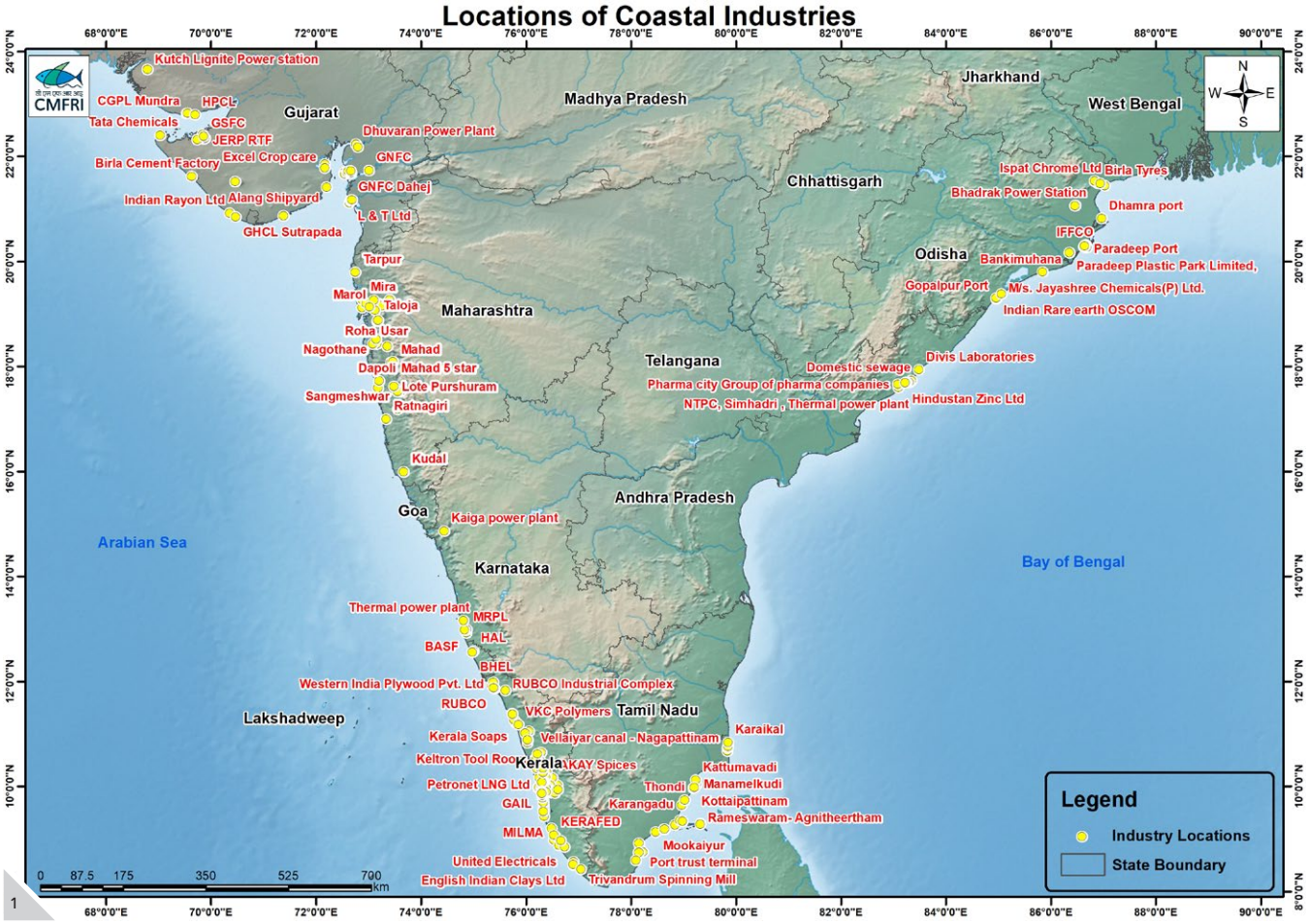
1. Fishes in the reef sites
2. *Quantity (tonnes -dry weight) of seaweed harvested from Tamil Nadu coast during 2018*
3. Attachment of sea grass species -*Cymodocea serrulata* and *Syringodium isoetifolium* on PVC rafts as a part of restoration experiment at Chinnapalam near Rameswaram, Tamil Nadu.

Abatement of coastal pollution through bioremediation

Research Project : FEM/PLN/28

The main industries located along the Indian coast was mapped. The list is being updated and will be complete only by this year end.

At CMRI Kochi, bioremediation of the fish processing industrial effluent was done using aquatic weed and compared with control. There was perceptible decline of toxic nitrogenous waste and improvement in water clarity, odour but the ammonia content did not show much reduction. Heavy metal like copper, cadmium, lead and zinc were analysed for fishing



industry sample but all the heavy metals are below the detection level.

At Tuticorin, the ability of commercial product of detritus degrading, euryhaline bacteria *Bacillus cereus* "Detrodigest" under different treatments were tested. The experiment ascertained the utility of the bacterial strain in reducing the deleterious parameters like BOD, NH_3, PO_4 and SiO_3 of the effluent sample especially at 50% dilution level, and it also warrants the need for conducting more trials for the process of reducing the nitrite and nitrate level of the effluent sample. Experiment conducted at Kochi, Tuticorin and Veraval indicated that seaweed species have varying capacity to reduce the deleterious parameters at different levels. Results of trial conducted using algae showed that they were very effective in reduction of TAN, Nitrate, Nitrite and Phosphate in sewage wastewater.

Nannochloropsis sp was found to have best phytoremediation potential as well as growth followed by *Isochrysis* sp and *Chaetoceros* sp among the three microalgae studied

1. Locations of industries along selected districts along Indian coast
2. Map of Mulavukad Panchayat indicating the ward boundaries (left) and with different grades based on Ecosystem index value (right)

The assessment of coastal marine pollution in selected maritime states of India

Research Project: FEM/PLN/SUB/28

Marine debris on the sea floor off Vishakhapatnam was estimated as 18.18 kg km^{-2} by swept area method using data obtained from 23 experimental bottom trawling surveys.

In the qualitative estimation of plastic contamination in the sediments of four beaches of Tuticorin with varying level of Fisher's interference and cleaning measures showed that density of total plastic litter was maximum at the Inigo Nagar beach sediments while weight- wise plastics litter was highest at Vellapatti.

The litter contamination studies along Gulf of Mannar and Palk Bay coast indicated the dominance of nylon ropes and net pieces.

The assessment of beach litter during flood period along selected beaches of Kerala coast indicated that the mean total weight per square meter was highest in South Kerala and the mean total number of litter items were more in North Kerala.

Along Veraval coast in four beaches, the mean abundance of marine litter was found to be 76±4.24 items m^{-2} (19 – 158 items m^{-2}) and mean weight 22.47±1.03 g m^{-2} (4.17–40.18 g m^{-2}). The major contributing factor for the accumulation of marine litter is the recreational activities from land based sources (78.50%). The results indicated that, plastic litter forms 59.71 to 76.98% of the items collected (mean 66.82%). The temporal variation revealed that, the marine litter abundance varied significantly between the months ($p<0.05$).

An evaluation of the impact of effluents discharge of fish processing waste on coastal water quality along Veraval coast indicated high concentration of BOD and ammonia in harbours and bar mouth stations.

The assessment of the water quality parameters influencing the ecosystem in the estuarine area of Mangalore coast revealed that the influence of salinity was the highest in the system and diagonally opposite to that of nutrient silicate, indicating that rainfall and consequent river discharge played a key role.

Micro-level environmental management plans (EMP) for selected critical habitats for ecosystem health and sustainable production

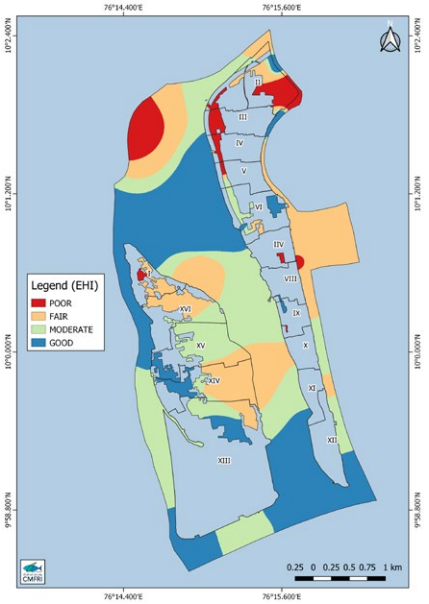
Research Project: FEM/HBT/27

An ecosystem index was developed. Water quality was assessed using physical, chemical, biological and microbiological indicators and based on PCA analysis, selected parameters were scored using linear scoring function and these scores were combined into a normalized ecosystem index reflecting the system's overall health, using R software. These zones were categorized as poor, fair, moderate and good based on <25th, 25th–50th, 50th–75th and >75th percentile values of the normalized ecosystem index and the area under each category was mapped.

Developed a community based participatory model protocol for micro level EMP for reducing litter accumulation in water bodies in two wards of Mulavukadu coastal village, in three sequential phases.

Protocol for plastic litter management in coastal village: A success story

One of the major environmental problems in coastal ecosystems was found to be dumping of waste and practically no working waste management initiative



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was in place. This was found to clog the canals leading to habitat degradation and biodiversity loss, thereby affecting the fisheries.

An initiative namely Nirmaladhara (Pure flow) was started to revive the coastal ecosystems with good flowing water and abundant resources.

A practical method to collect and remove household plastic waste was developed through a participatory village level program

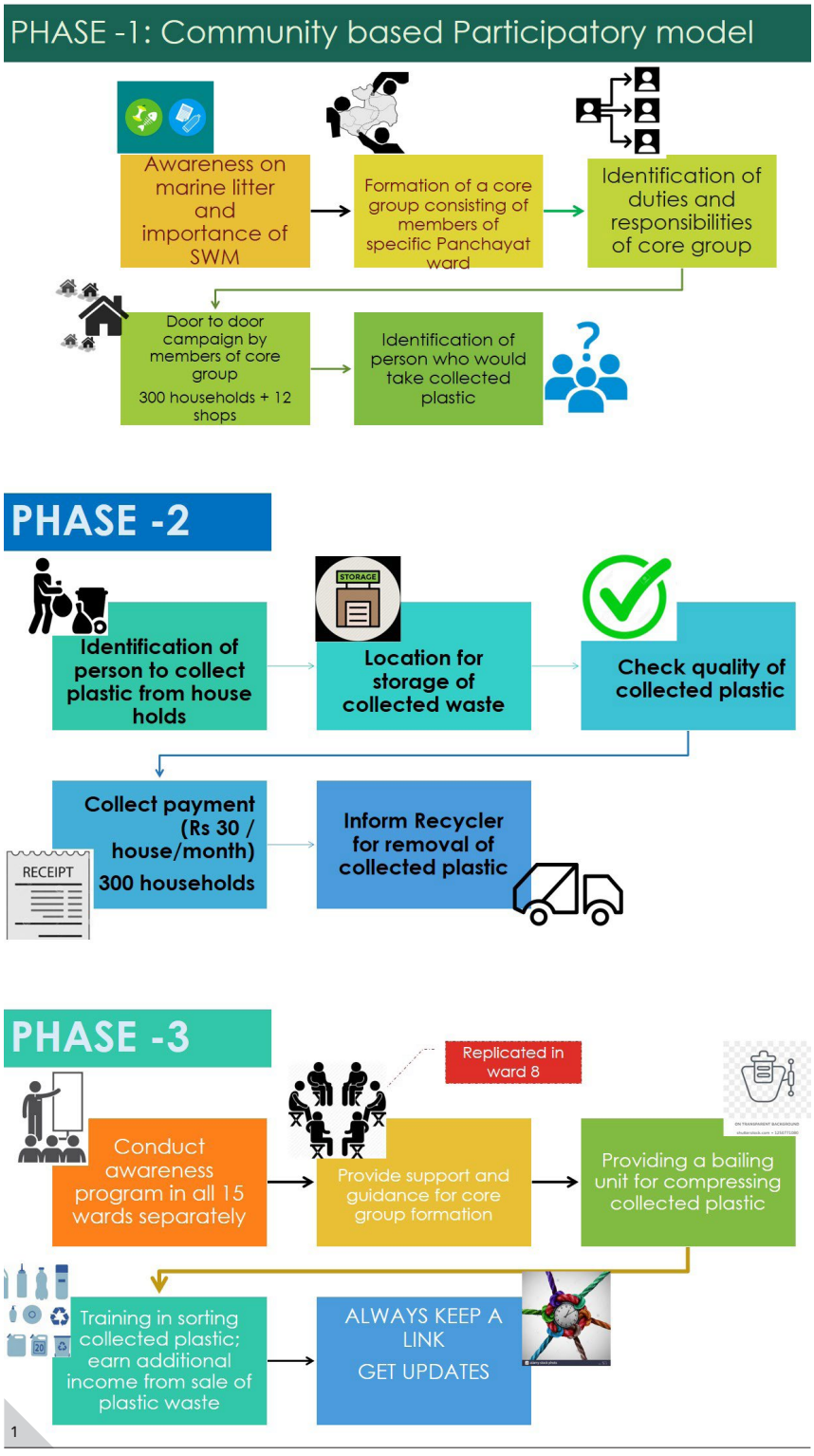
From June 2018 to January 2019, about 2.5 tonnes of plastic removed from households which would have otherwise entered the estuary. It is estimated that about 345 tonnes of plastic can be effectively managed per annum if this protocol is successfully adopted in this Panchayat which has about 16 wards each with average 300 households

In Gujarat, high level of biological oxygen demand (BOD) and total ammonia nitrogen (TAN) values with poor water quality index was observed in the mangrove habitats of the Porbanadar coast.

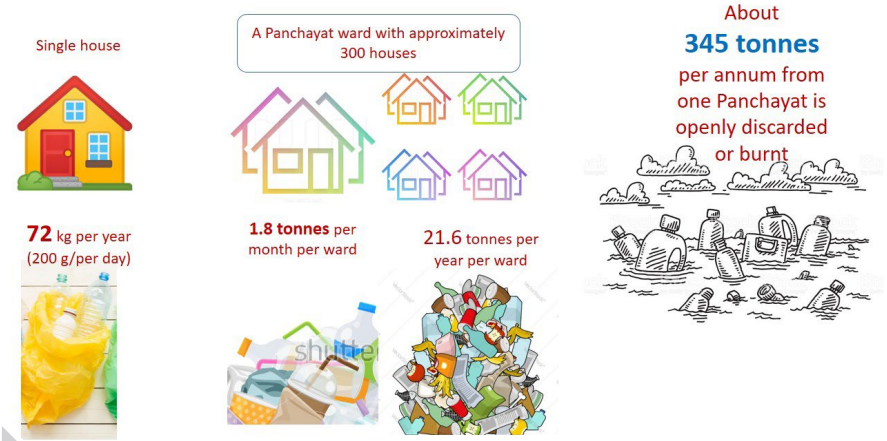
In Tuticorin, the health conditions of the selected estuary (Pazhayakayal) was found critical at the effluent entry point of the fish processing unit.

In Andhra Pradesh, selected ecosystems were assessed for water quality (nutrients and total chlorophyll) and their variations in Bhimli estuary were mapped.

In Karnataka, a stakeholder meeting on Micro-level management plans for e-waste disposal at Ullal was conceptualized and organized and a demonstration on wire stripping machine was carried out on 17.1.2019 at City Muncipal Council



1. Protocol for plastic waste collection in villages in three phases
2. Estimated plastic waste management in one coastal Panchayat with 300 households per ward
3. Anticipated benefits of effective plastic waste management in a coastal Panchayat with 16 wards
4. Dissolved inorganic nitrogen (DIN), Dissolved inorganic phosphorus (DIP) and total chlorophyll levels in the Bhimli estuary during 2018-19



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3 Anticipated benefits of micro-level EMP- When adopted by Mulavukad Panchayat, Kerala

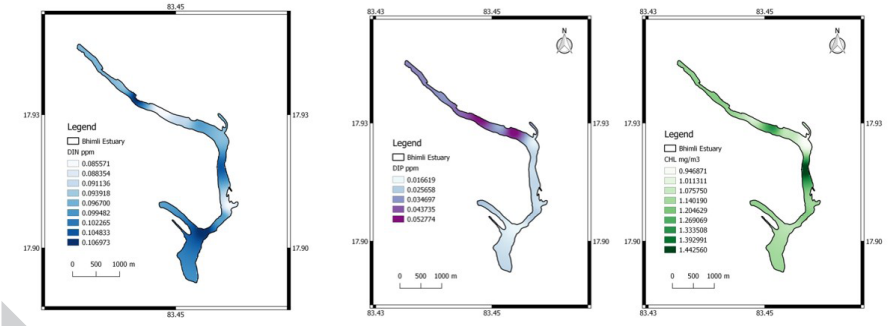
Ullal, with the involvement of the private company manufacturing a mechanical wire stripping machine.

In Mandapam, awareness creation, interaction with local fishers individually regarding control of plastic pollution and non-biodegradable waste management had been done

Spatial Database on Turtle Nesting Intensity along Indian Coast

The very low intensity of turtle nesting along the west coast does not warrant use of TEDs in trawls along the west coast of India. However, as a precautionary measure, trawl fishers may be advised to use them in their trawl nets with adequate state support and incentives.

Since there are possibilities of incidental turtle capture in trawl nets, particularly along the east coast states, the use of turtle excluder devices (TEDs developed by CIFT) has to be made mandatory on all trawl nets in trawl vessels. Necessary rule changes have to be made in the MFRAs by the respective



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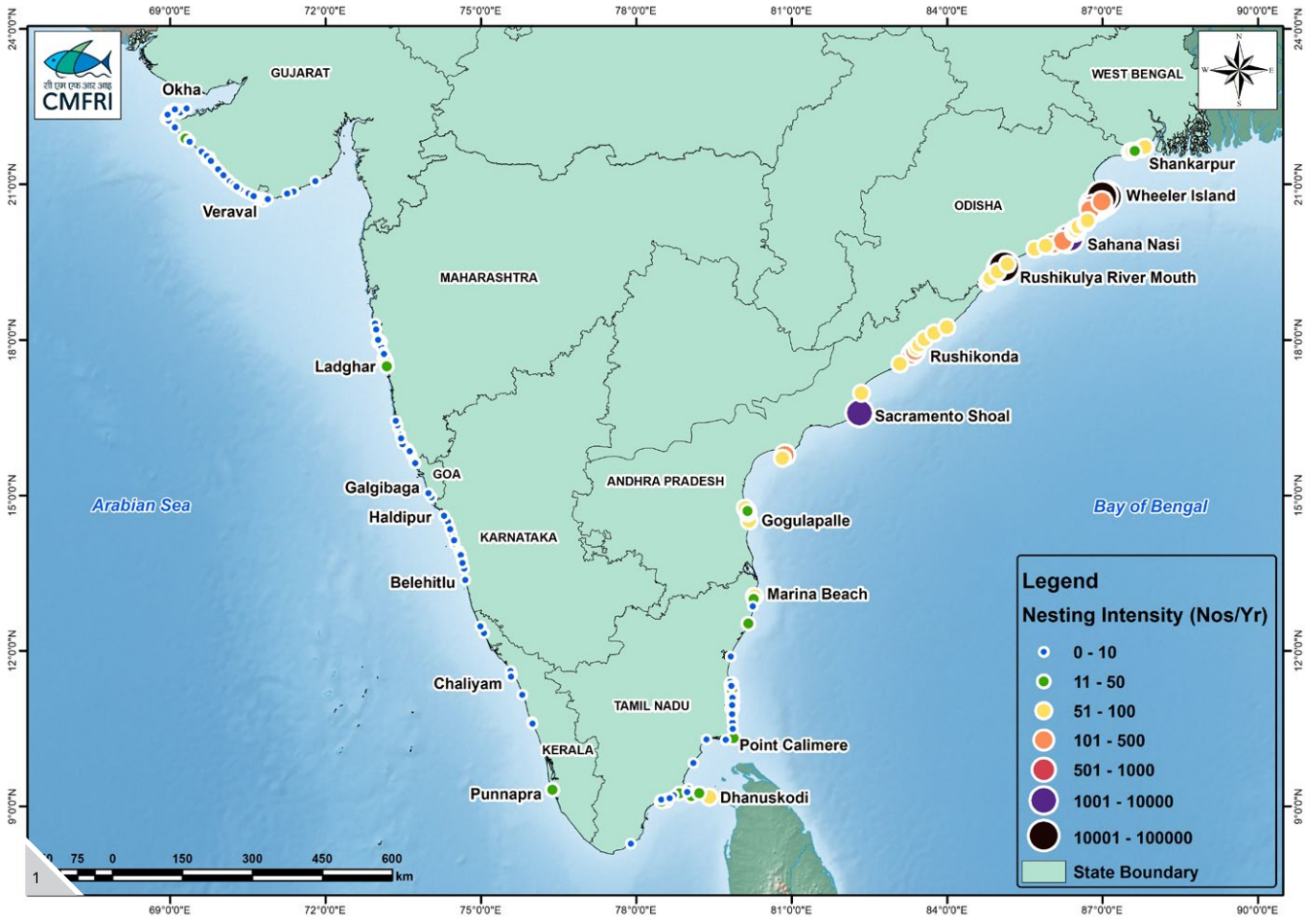
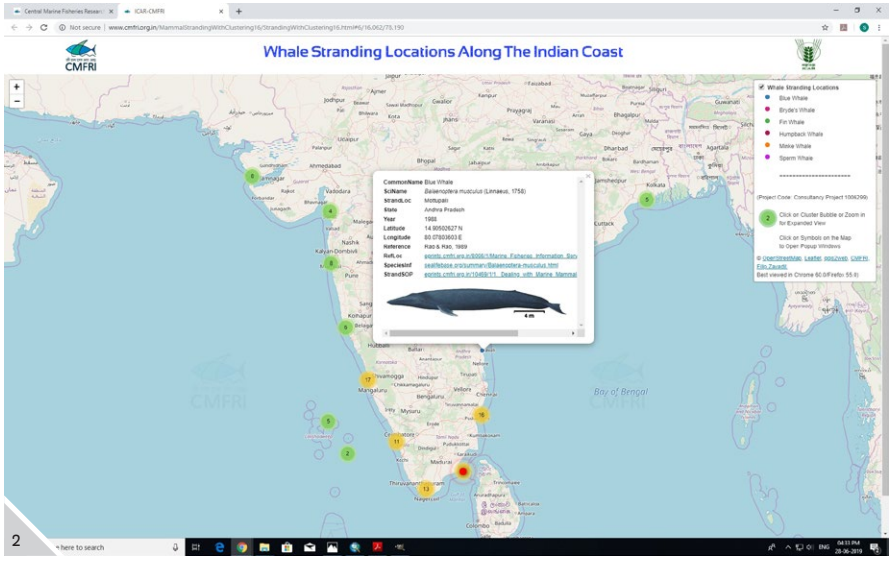
Marine Habitats





1. Spatial distribution of turtle nesting sites along Indian coast
2. Screen shot of the Interactive map on whale stranding locations.

maritime states of the east coast. Periodic inspections during annual license renewal have to be done to ensure compliance. Financial schemes and incentives maybe developed by government agencies.

Turtle nesting has been observed along Indian coast with varying intensity. The turtle nesting intensity (*ie.* the average number of turtles arriving for nesting per year) data was collected from 221 sampling locations covering 46 districts, 9 states and 2 union territories through a rapid survey during October to November, 2018. This data was used to analyse the pattern of turtle nesting along the Indian coast using ArcGIS 10.0 software.

Digital Database and Interactive Web Map on Whale Stranding Along the Indian Coast

An interactive map of whale stranding locations has been developed and hosted in the Institute website. The map gives locations of the strandings, and stranding hot spot area.

The popup window of each stranding location will give information like, common name, scientific name, stranding location, state, year, latitude, longitude, reference, URLs (web address) for references, species information and Standard Operating Procedure (SOP) during stranding. Up on clicking these URLs, respective sites will be opened and one can access the required information.

Assessing the performance of Artificial Reefs deployed along North Tamil Nadu Coast

Research Project: MCD/FAD/21

The state of maturation of artificial reefs deployed at selected sites along north Tamil Nadu coast were assessed and the impact of the artificial reefs on habitat, biodiversity, resource abundance, fishery and socio-economic implications were studied. The sites studied included reefs in Thiruvallur, Kancheepuram and Villupuram districts, deployed in 2014, 2015 and 2018, at depth zones ranging from 7.5 to 17.25 m. The reef designs also differed between the sites (Table 1).

The reef assessments are being done through a combination of different methods – underwater dives with photo and video documentation, fishery based assessment, passive assessment, reef community assessment and socio-economic assessment through questionnaire-based surveys.

Reef structures are withstanding the seasonal drifts and swells during monsoon and even cyclonic weather.

The position of the structures do not alter much and the structures do not collapse.

Hydrological paramerters were same while variation in sediment texture was observed; finest and finer sizes tend to gather in the initial phase, for about 6 months, followed by coarse and bigger gradients.

High settlement of attached/associated life (on the reefs) with shorter life expectancy, such as barnacles, clams, mussels, gastropods, foraminiferans, coralline algae, polychaetes, sponges, echinoderms, smaller invertebrates and vertebrates contributed to coarser sediments as they decay and perish.

Zooplankton densities were very high in the bottom waters at reef sites, and were comprised predominantly of fish eggs & fry, decapod and molluscan larvae, large gelatinous plankton and copepods.

The percentage occurrence of each fish species was categorized into four groups–permanent (>75%), frequent (75-30%), scarce (30-10%) and rare (<10%). Occurrence was taken as the number of encounters of a species during all the surveys (sighting frequency) and fishing

Table 1. Details of artificial reef sites studied

District	Reef site studied	Month and year of deployment	Depth of deployment (m)	Reef design	Number of modules
Kancheepuram	Kovalam	March 2014	14	Old design (scattered)	200
Kancheepuram	Chemmencherry	June 2015	13.5	Old design	200
Kancheepuram	Karikattukuppam	January 2018	17.25	Modified designs with coconut fronds	225
Villupuram	Mudaliarkuppam	October 2017	10	Modified designs with coconut fronds	225
Villupuram	Goonimedukuppam	October 2017	10	Modified designs with coconut fronds	225
Thiruvallur	Koraikuppam	January 2018	7.5	Modified designs (pinnacles)	225
Thiruvallur	Sattankuppam	January 2018	11.5	Modified designs (pinnacles)	225

(abundance) carried out at the site.

Snappers, pig-face breams, sea breams, rock cods and barracudas were identified as permanent groups. Seerfishes, tunas, trevallies, mackerel, crabs and cephalopods were frequent groups, while eels, threadfins and whitings were scarce. Whale sharks and sting rays were encountered as rare fishes in the reef sites. Different groups of fauna observed in the reefs is given below.

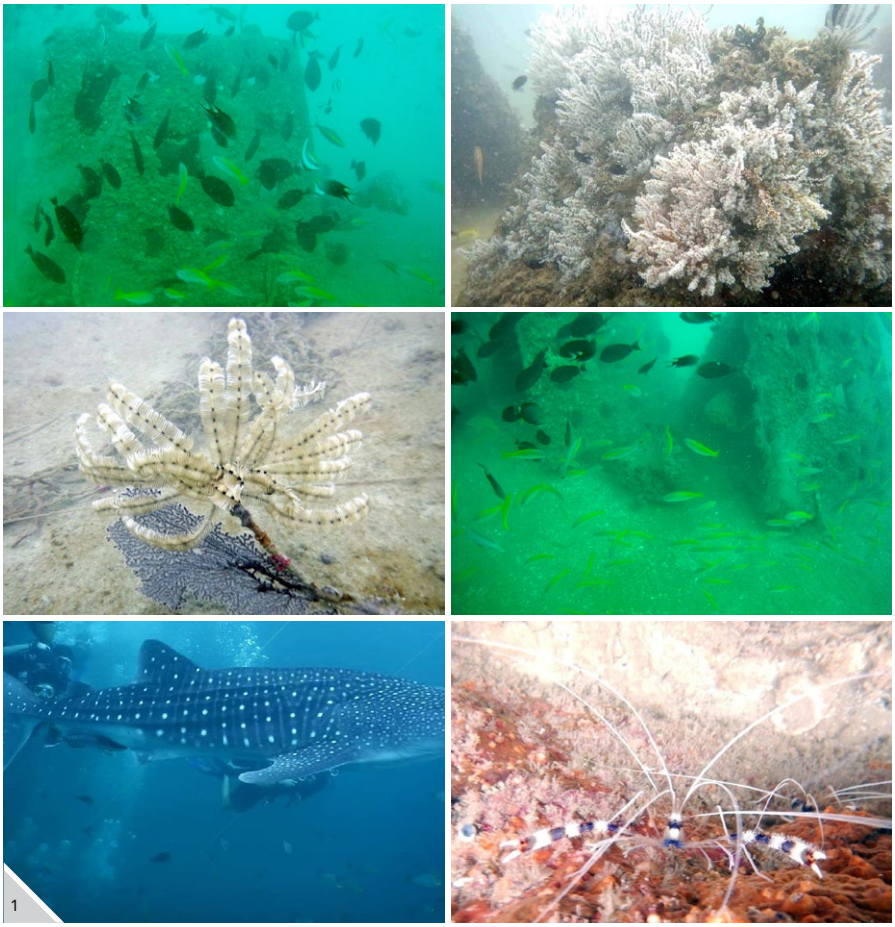
In Kancheepuram district, where artificial reefs have been in the coastal waters of twelve villages, there has been a considerable increase in the fishery by non-mechanized sector during the year 2018, compared to earlier years. Fishermen attribute this to the increased availability of quality fishes that can be targeted by hook & lines in particular, at the reef sites.

Analysis of the fish landings at landing centres adjacent to artificial reef installed in Kovalam village at Kancheepuram district showed a considerable increase in the quantum of certain resources in 2018, compared to 2016. Barracudas, billfishes, catfishes, crabs, leather-jackets, perches, pig-face breams, rock cods, seerfishes, scads, silverbellies, anchovies, threadfin breams, half-beaks and full-beaks, mackerel and ribbonfishes showed a perceptible increase.

Experimental fishing was done using small hooks and false baits (10-15 gilt strips in one string), which were lowered on top of the reef site and pulled up and down frequently. Surface gill nets set on the side of the reefs at drift time were used to capture shoals of resident barracudas, along with mackerel and scads. Cuttlefishes were also observed in the catches.

Fishermen perspectives

Fishermen occasionally report capture of large rock cods giving bigger revenue at each effort from the site. Post monsoon, the clear waters give better yield on the small hooks and bring in good quantities



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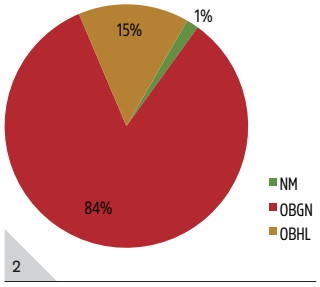
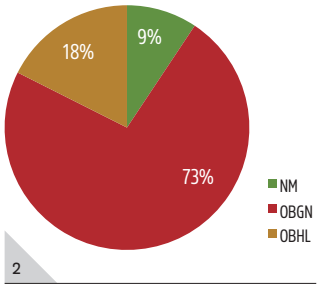
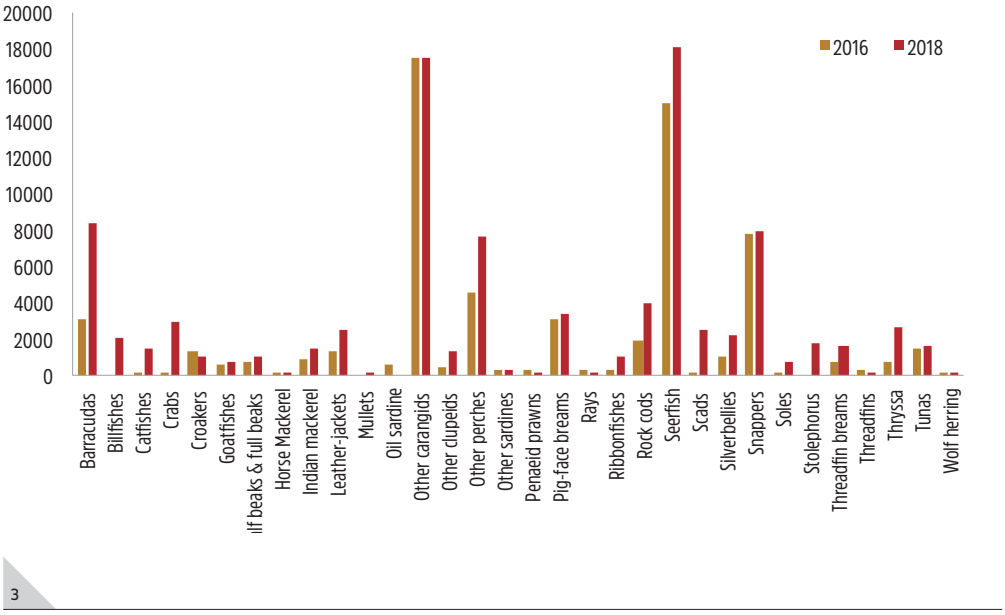
1. Fish and other faunal aggregations in the reef sites
2. Comparison of proportion of catch by different gears in Kancheepuram district during 2016 and 2018; NM = Non-motorised, OBGN = motorised Gill net, OBGN = motorised Hook & Line
3. Comparison of the fish landings in landing centres adjacent to artificial reef installed in Kovalam by motorized Hook & Line and non-motorized gear during 2016 and 2018

Marine Habitats







of live scads, mackerel and carangids, which are used as live baits to catch the larger tunas, seer fishes and dolphin fishes in deeper waters. This is a high revenue operation and the role of reefs has been very encouraging.

Fishermen ranked the fish species, based on their availability at the reef sites (Table 2). Some species were found to rank high across different sites, while some were exclusive to certain sites.

Table 2. Ranking of fish species by fishermen based on availability at reef site

District	Reef site studied	Month and year of deployment	Depth of deployment (m)	Reef design	Number of modules
Kancheepuram	Kovalam	March 2014	14	Old design (scattered)	200
Kancheepuram	Chemmencherry	June 2015	13.5	Old design	200
Kancheepuram	Karikattukuppam	January 2018	17.25	Modified designs with coconut fronds	225
Villupuram	Mudaliarkuppam	October 2017	10	Modified designs with coconut fronds	225
Villupuram	Goonimedukuppam	October 2017	10	Modified designs with coconut fronds	225
Thiruvallur	Koraikuppam	January 2018	7.5	Modified designs (pinnacles)	225
Thiruvallur	Sattankuppam	January 2018	11.5	Modified designs (pinnacles)	225

Climate Change

National Innovations in Climate Resilient Agriculture (NICRA) project

Research Project:EF1

Phenology and Distribution

Prevalence of disease in demersal fishes in relation to rise in sea bottom temperature

Histopathological, morphological and molecular analysis of parasitic infestation

1

in fishes belonging to the family Lutjanidae and Priacanthidae reveals that the infestation disrupted the ovarian lamellar walls, causing atrophy and are philometrid nematods belonging to the superfamily Dracunculoidea Stiles, 1907. This is the first report of gonad-infecting philometrids *Philometra philippinensis* from the fish *Priacanthus hamrur* from the tropical waters off southeastern Arabian Sea.

Larval, plankton and fish distribution studies

Fish larvae and shrimp post-larvae were almost exclusively found in nearshore areas, whereas molluscan larvae were distributed further off-shore near the 20-30 m depths off Vishakhapattanam.

A clear seasonality was observed with winter months having higher plankton concentrations with highest of 0.29 ml/m^3 recorded on February. Preliminary habitat analysis along Maharashtra coast revealed that Indian mackerel preferred habitat range for SST, SSS, SSH and MLD as 26-28°C, 33-34.5 ppt, 0.37 m and 10-15 m respectively. Preliminary analysis on jellyfish abundance in Maharashtra coastal waters reveals correlation with environmental variables with dominant influence by salinity and sea bottom temperature.

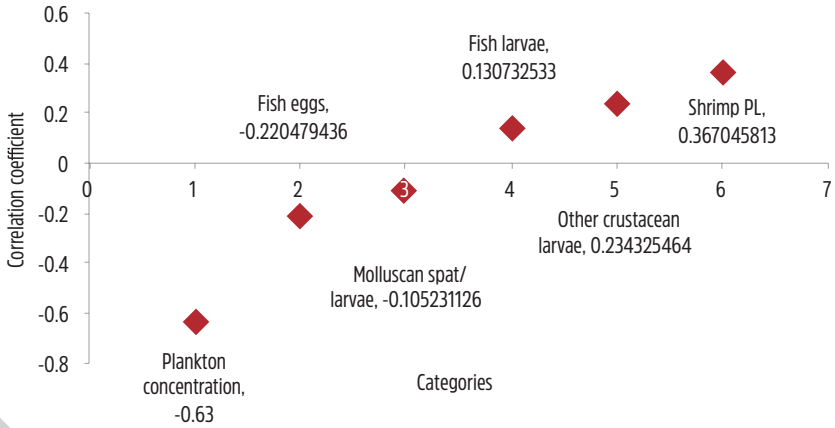
Carbon foot print and blue carbon

Carbon assimilation potential of seaweed and seagrass biomass from Gulf of Mannar

The carbon sequestration potential for the improvised monoline plot with the production of seaweed biomass for the period 2018-19 was estimated as to absorb 9.6 CO_2 tonnes per day out of which 2.5 tonnes of CO_2 was emitted per day. The carbon assimilation potential of 8,445 tonnes of commercially important seaweed biomass along Gulf of Mannar was estimated as 450.3 tonnes CO_2/day against 14.5 tonnes of CO_2 emitted/day.

Carbon assimilation potential of mangrove ecosystem

Estimation of above ground mangroves biomass from Punnakayal, Palayakayal and Tuticorin region of Tamil Nadu revealed carbon assimilation potential as 635.6 Gigagram carbon per year. In Kerala, the estimates of mean combined C-stocks in mangrove and sediment of



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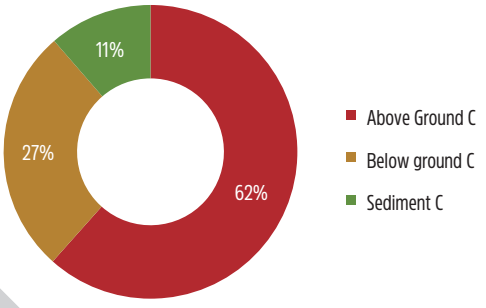

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1. IMTA farming at Munaikadu, Ramanathapuram district
2. Correlation of plankton, fish eggs and various larval groups with SST off Visakhapatnam
3. The percentage share of carbon in above-ground, below-ground (root) and sediment pools of Thalassery wetland

Thalassery estuarine wetland stored 563.86 t CO_2 ha^{-1}.

Climate change modeling

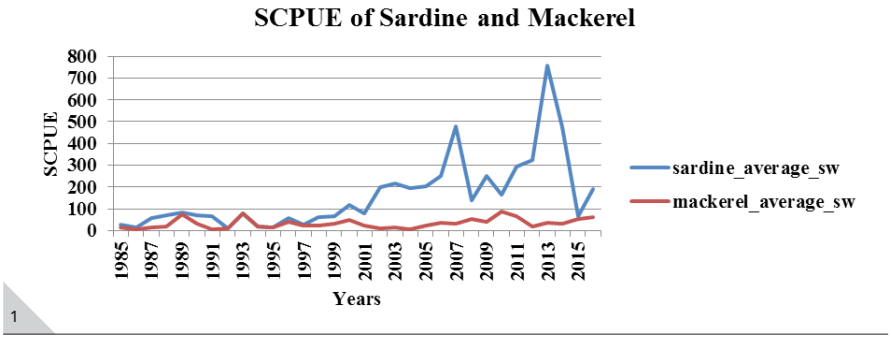
Time series analysis of CMIP5 model and observed SST anomaly along Indian coastal zones

Comparison of CMIP5 model historical data with the observed value (ICOADS) reveals warming trend in all coasts, but with noticeable differences in values among both, which emphasize that error corrections need to be applied in futuristic SST projections and related studies of Indian fisheries.

Implications of climatic variability on Indian oil sardine and mackerel fishery

A new approach of Multi-Criteria Analysis model reveals that upwelling acts as a major forcing for biological productivity and fishery of oil sardine during 2000 - 2007 along the southwest coast of India. It was also found that mackerel is less dependent towards mixed layer temperature and upwelling than Indian Oil Sardine.

Correlation analysis, GAM model and resultant best fit model reveal that the SST and salinity showed a negative relation whereas precipitation is positively related to the catch of Indian oil sardine along Kerala coast. The investigations on linkages of Indian mackerel diet changes indicate that occurrence of copepods in the gut is influenced by precipitation and chlorophyll *a*, that of Diatoms by precipitation and SST and that of Dinoflagellates by Precipitation and Ekman transport.



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Climate resilient technologies

National resilience framework for small wetlands and fisheries

A MOU was signed between ICAR-CMFRI, Kochi and Space Applications Centre (ISRO), Ahmedabad on 8th April 2019 at SAC campus at Ahmedabad with focus on developing a centralized web portal and mobile application for integration of field level regional wetland data with geospatial datasets so as to enable real-time wetland advisories. This is the first national instance in which a fisheries institute is collaborating with ISRO to develop a comprehensive climate resilient framework for fisheries and wetlands.


2

E-Commerce implementation training for Govt. of Himachal Pradesh

A multivendor e-commerce website and associated mobile app was developed for enabling direct sales and marketing between fishers and customers, which was released by Hon. DG, ICAR on 7th December 2018 at NAS, New Delhi.

The Directorate of Fisheries, Himachal Pradesh sought the technical guidance of ICAR – CMFRI to implement the similar app and web portal for the state of Himachal Pradesh. Accordingly implementation training was provided to HP state fisheries officials, administrators and farmers.

Climate resilient seaweed farming practices using improved monoline method at Mullakadu Coastal Village, Thoothukudi District, Tamil Nadu

Field demonstration at Tuticorin, Tamilnadu revealed that on an average farmers got yield of 10 tonnes of seaweeds (5 fold increase) from a single plot within a culture period of 30-35 days with a net revenue gain of Rs. 35,000 to Rs.40, 000/- per plot. Owing to success, State Fisheries Department of Tamil Nadu, Tuticorin is planning to provide subsidies for improvised seaweed farming practice.

Integrated Multi Trophic Aquaculture

Demonstration and farming of Sea cage farming of cobia *Rachycentron canadum* along with the rafts of seaweed *Kappaphycus alvarezzi* yielded additional production of cobia (12%) and seaweed (50%) and thereby revenue improvement. In Padanna estuary of Kasaragod, Kerala, *Kappaphycus alvarezii* was introduced in floating rafts and kept afloat in mussel rens. The biomass after 60 days was harvested which revealed that Padanna estuary supports seaweed growth while simultaneously supporting mussel production.

Climate Smart Village (CSV) development

Vulnerability assessment of coastal villages

Vulnerability mapping of coastal villages and taluks of Tuticorin, Tirunelveli and Kanyakumari of Tamilnadu were done. Vulnerability Index was high in Vilavankode taluk of Kanyakumari District

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4

1. The trend of Indian oil Sardine and Indian mackerel along the southwest coast of India from 1985 to 2016
2. MOU signing event between NICRA, ICAR-CMFRI Kochi and Space Applications Centre (ISRO), Ahmedabad
3. Release of E-Commerce Website and Mobile App of CMFRI by DG, ICAR
4. Implementation training for Govt. of Himachal Pradesh

Climate Change

1

whereas it was high in Thoothukudi Fishing Harbour (0.3076) followed by Therespuram (0.2243) fishing village for Thoothukudi district. Assessment of the vulnerability index based on village-level survey revealed a high overall vulnerability index of 0.704 for the Thiruvallur district. Vulnerability Indices revealed that Karunkali village was most vulnerable, followed by Koraikuppam, Ernavurkuppam and Kattupallikuppam. The direct impact relates to loss of livelihood and sustenance sources due to habitat destruction and dwindling of

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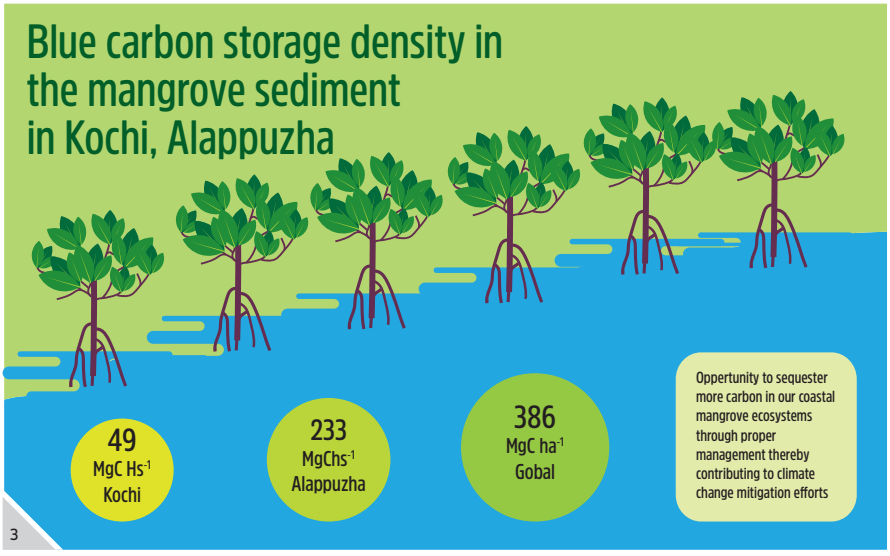


1. IMTA farming at Munaikadu, Ramanathapuram district
2. Partial harvest of multiple species of fishes in restored wetland of Edakochi village, Kerala
3. Comparison of mean sediment blue carbon storage density in the mangroves of Kochi

fishery resources. Training and capacity building programs on Marine Ornamental Fish Culture, IMTA, imparting awareness on plastic pollution and planting of mangroves were carried out at selected villages of Tamil Nadu.

At Mangalore coastal population, affected with climate change related low income from the sea and estuaries were empowered with alternate income generation through introduction and demonstration fisheries and agriculture related technologies which benefited more than 40 families.

Partial harvest of multiple fish species in restored wetland of Edakochi village

The restored wetland (around 5 acre) with multispecies aquaculture withstood the Kerala Floods, though some stocks were lost. A partial harvest was done with moderate yield and the juveniles produced within were preserved as stock for consequent farming and further technical support was extended.

Impact of climate extremes and disasters on ecosystem functioning with special emphasis on fisheries and mariculture

Research Project: FEM/HBT/SUB/27

Impact assessment of Kerala Flood 2018 on the hydrology of Ashtamudi and Vembanad Lakes and intertidal region shows high increase in dissolved inorganic nitrogen, total ammoniacal nitrogen and total chlorophyll compared to pre flood period. Salinity dropped to zero for the estuarine as well as coastal surface waters for around 2 weeks, indicating stratification probability. The high productivity in the area during post-flood period along with deficit north- east monsoon would have supported intense settlement of mussel in the estuaries which was beneficial to mussel farmers. Response to short- term abiotic stress simulations on commercially important farmed resources indicated that harvest of farmed mussels must be done within 12 hrs if salinity drops below 25ppt or goes above 35 ppt and also if surface water temperature is above 34°C. Similarly fishes were found to be prone to diseases like fin-rot due to salinity stress.

Estimation of blue carbon stock of mangrove sediment in Vemabanad Lake shows mean values much below the global average. An inventory of sediment blue carbon stock of the mangrove patches of Alappuzha district was also generated.

Economic sustainability and trade

Valuation of marine fish landings, economic performance and supply chain management

Research Project: (SEE/SOC/33 and SEE/DCD/35)

Valuation of marine fish landings

The estimate of the value of marine fish landings during 2018 at landing centre level was Rs. 52,636 crores, (0.39% increase over 2017). The unit price per

1

Economic sustainability and trade

kg of fish at landing centre was Rs.151.97, (11.14 %). At the retail level, the estimated value was Rs. 80,320 crores (2.44 % increase over 2016). The unit price at the retail market level was Rs.231.89 (13.41%) The marketing efficiency determining the producer's share of the consumers was found to be 65.53 (2.00 % decrease over 2017)

Species-wise Valuation of marine fisheries in India

The valuation of Indian fisheries vis-a-vis landings – major species is given below. Although the Indian mackerel registered the highest landings; they contribute 8.10 per cent of value of share in the landings. Due to reduced share of the oil sardine and threadfin breams landings

Valuation of marine fish landings

Parameters	2010	2011	2012	2013	2014	2015	2016	2017	2018
Valuation at Point of first sales ('000 crores)	22.75	24.37	24.89	29.10	31.75	40.10	48.38	52.43	52.63
Valuation at Point of last sales ('000 crores)	36.89	38.15	38.56	46.25	52.36	65.18	73.29	78.40	80.32
Fishermen Share of Consumers Rupee (%)	61.66	63.88	64.55	62.92	60.65	61.52	66.01	66.87	65.53

Species wise share marine fish landings

Species	Landings (in tonnes)	Share (%)
Indian mackerel	280,510	8.10
Ribbon fishes	194,166	5.61
Non-penaeid shrimp	193,902	5.60
Penaeid shrimp	192,241	5.55
Threadfin breams	183,718	5.30
Other sardines	180,121	5.20
Oil sardine	155,450	4.49
Other perches	106,617	3.08

State-wise Valuation of fish landings across states ('000 crores)

State	Landing centre valuation			Retail Centre valuation		
	2017	2018	Share	2017	2018	Share
Gujarat	9931	11536	21.92	14729	17382	21.64
Maharashtra	6397	5771	10.96	9488	8510	10.59
Goa	1245	920	1.75	1796	1312	1.63
Karnataka	6639	6442	12.24	10196	10470	13.03
Kerala	9699	10827	20.57	13501	14969	18.64
Tamil Nadu	6807	8576	16.29	11088	14464	18.01
Andhra Pradesh	2679	2662	5.06	4043	4159	5.18
Odisha	1729	1255	2.38	2901	2159	2.69
West Bengal	5783	2759	5.24	8490	4184	5.21
Daman Diu	1089	1156	2.2	1557	1664	2.07
Puducherry	432	733	1.39	618	1050	1.31
Total	52,431	52,636	100	78,408	80,320	100

in 2018 their share in value came to a low of 4.49 per cent and 3.08 per cent respectively.

State-wise Valuation across the value chains

Gujarat recorded the highest realization of prices at the landing center with retail centers registering a growth of 21.92 per cent and 21.64 per cent respectively over 2017.

Macroeconomic indicators in marine fisheries sector

At the national level (macro level) the total operating cost was estimated at Rs.28,950 crores and the net operating income at Rs.23,686 crores. The average capital productivity worked out to 0.55 and the gross value added to the marine fisheries sector was estimated at Rs.35,266 crores.

Economic performance of marine fishing methods

The economic performance of various fishing methods were assessed by working out the economic indicators like net operating income, capital productivity (operating ratio), labour productivity, input-output ratio and gross value added. The significant findings across the states are given below.

Mechanized fishing methods

Single day trawl fishing

It is seen from the table that the capital productivity was highest in single day trawl operating fish trawl net in Tamil Nadu followed by shrimp trawl net in Tamil Nadu (0.45) and Kerala (0.61). The gross value added (GVA) was also highest in fish trawl net in Tamil Nadu (Rs.25,289) and the GVA as a per cent share of gross revenue (57.26%) was also highest in this method of fishing.

Multi-day trawl fishing

It is seen from the table that the capital productivity was highest in multi-day trawl fishing (4-5 days) in Karnataka with the lowest operating ratio of 0.60 (lowest operating ratio mean highest capital productivity) followed marginally by multi-day (5 days) in Kerala and multi-day (4-5 days) in Tamil Nadu. However, the gross value added (GVA) at Rs. 6,42,080 and the GVA as a per cent share of gross revenue (80.49%) was the highest in multi-day trawl (4-5 days) fishing in Tamil Nadu.

Motorized fishing methods

It is seen from the table that the capital productivity was highest (with lowest operating ratio) in motorized single day other bottom set gill net (OBSGN) at 0.64. However, the gross value added was highest for motorized multi-day gill net

Marine Fisheries in Indian Economy: Macro-economic indicators 2018-19

Sl.No.	Macroeconomic Indicators	Value (in Rs. crores)
1	Value at landing Centre (in Rs. crores)	52,636
2	Total operating cost (in Rs. crores)	28,950
3	Net operating income: (in Rs. crores)	23,686
4	Average Capital Productivity	0.55
5	Gross value added (in Rs. crores)	35,266

Economic performance of single day trawl fishing

	Economic indicators	Kerala	Tamil Nadu (Fish trawl)	Tamil Nadu (Shrimp trawl)
1	Total Operating cost (Rs.)	11555	21205	26348
2	Gross revenue (Rs.)	12935	40177	42538
3	Net operating income (Rs.)	1380	18973	16190
4	Capital productivity (Operating ratio)	0.89	0.54	0.62
5	Labour productivity (kg/crew/trip)	17.49	249	69.8
6	Input-output ratio	0.61	0.39	0.45
7	Gross value added	4993	25289	23271
8	GVA as a per cent of gross revenue	38.6	57.26	54.71

Economic sustainability and trade

at Rs.18,579 and the GVA as a per cent of gross revenue was highest in single day bottom set gill net (BSGN) at 50.58 per cent.

As Tabled, in Kerala, the capital productivity (lowest operating ratio of 0.69), gross value added at Rs.6,531 and the GVA as a percentage of gross revenue (76.61%) were the highest in case of the single day drift gill net among the three gears namely hooks & line, set gill net and drift gill net.

It is seen from the table that in Andhra Pradesh, among the four motorized gears namely *jagavala, discovala*, hook & line and *naravala* the capital productivity (lowest operating ratio) was highest in

Economic performance of multi-day trawl fishing

	Economic indicators	MDF (4-5 days) Andhra	MDF (4-5 days) Tamil Nadu	MDF (4-5 days) Karnataka	MDF (>5 days) Kerala
1	Total Operating cost (Rs.)	2,34,734	5,00,184	5,97,026	3,12,267
2	Gross revenue(Rs.)	3,89,364	8,03,543	6,71,751	4,92,867
3	Net operating income (Rs.)	1,54,630	3,03,359	74,725	1,80,600
4	Capital productivity (Operating ratio)	0.60	0.64	0.89	0.63
5	Labour productivity (kg/crew/trip)	346	494	1,083	344
6	Input-output ratio	0.51	0.31	0.59	0.35
7	Gross value added	1,80,906	6,42,080	2,76,250	3,23,492
8	GVA as a per cent of gross revenue	46.50	80.49	41.12	65.6

Economic performance of motorized fishing methods in Tamil Nadu

Sl.No	Economic indicators	Multi-day (Gill Net)	SD (Bottom set Gill Net)	SD (Other Bottom set Gill Net)
1	Total Operating cost (Rs.)	27,591	1,264	1,492
2	Gross revenue(Rs.)	40,245	1,912	2,338
3	Net operating income (Rs.)	12,654	648	846
4	Capital productivity (Operating ratio)	0.69	0.66	0.64
5	Labour productivity (kg/crew/trip)	38.86	2.33	10
6	Input-output ratio	0.54	0.49	0.43
7	Gross value added	18,579	967	1,339
8	GVA as a per cent of gross revenue	46.16	50.58	57.27

Economic performance of motorized fishing methods in Kerala.

Sl.No	Economic indicators	Motorised single day H &L	Motorised single day set gill net	Motorised single day drift gillnet
1	Total Operating cost (Rs.)	7,036	8,325	5,858
2	Gross revenue(Rs.)	9,048	10,525	8,525
3	Net operating income (Rs.)	2,012	2,200	2,668
4	Capital productivity (Operating ratio)	0.78	0.79	0.69
5	Labour productivity (kg/crew/trip)	24	52	26
6	Input-output ratio	0.39.	0.42	0.23
7	Gross value added	5,537	6,050	6,531
8	GVA as a per cent of gross revenue	61.20	57.48	76.61

case of hooks and line (0.44). Similarly among these four gears, the gross value added at Rs.11, 260 and the GVA as a per cent of gross revenue at 92.20% was highest in case of *naravala*.

It is seen from the table that in Odisha, among the four motorized gears namely gillnet, *jagvala*, *discovala* and *gagaravala* the capital productivity (lowest operating ratio) was highest in case of *jagvala* (0.60). Similarly among these four gears, the gross value added was highest at Rs.9,011 in case of *gagaravala* and the GVA as a per cent of gross revenue was highest at 79.42% in case of *jagvala*.

Non-mechanied fishing

It is seen from the table that in Tamil Nadu and Andhra Pradesh, among the four gears operated, the capital productivity was highest in bottom set gill net (BSGN) in Tamil Nadu at 0.41. The gross value added was highest at Rs.11,704 in case of *naravala* in Andhra Pradesh and the GVA as a per cent of gross revenue was highest at 100 per cent in case of hook & line fishing in Andhra Pradesh.

It is seen from the table that in Odisha, among the four non-mechanized gears namely, *discovala, gagaravala*, hook and line and gillnet the capital productivity (lowest operating ratio) was highest in case of *gagarvala* at 0.34 operating ratio. Similarly among these four gears, the gross value added was highest at Rs. 21,400 in case of hooks and line and the GVA as a per cent of gross revenue was highest at 377.93% in case of *gagaravala*.

Price behavior of marine fish varieties: Landing Centre

Average landing Centre Price realization

The average landing centre price for major species ranged from Rs.90.13 per kg for oil sardines to Rs.309.32 per kg for penaeid prawns, closely followed by Non Penaeid prawns at Rs.174.15 per kg.

Note: WB- West Bengal, OR- Orissa, AP- Andhra Pradesh, TN- Tamil Nadu,

Economic Performance of Motorized Fishing Method –Andhra Pradesh

S.no.	Economic indicators	Motorized *Jagavala*	Motorized *Discovala*	Hook and Line	Motorized *Naravala*
1	Total Operating cost (Rs.)	4,529	4,671	3,259	6,582
2	Gross revenue(Rs.)	8,102	8,616	5,834	12,212
3	Net operating income (Rs.)	3,573	3,945	2,575	5,630
4	Capital productivity (Operating ratio)	0.56	0.54	0.44	0.54
5	Labour productivity (kg/crew/trip)	6.66	6.31	6.27	19.06
6	Input-output ratio	0.12	0.08	0.11	0.08
7	Gross value added	7,146	7,890	5,180	11,260
8	GVA as a per cent of gross revenue	88.20	91.57	88.79	92.20

Economic performance of motorized fishing methods – Odisha

Sl.No	Economic indicators	Motorized Gillnet	`Motorized *Jagvala*	Motorized *Discovala*	Motorized *Gagaravala*
1	Total Operating cost (Rs.)	4,153	5,288	5,028	6,981
2	Gross revenue(Rs.)	6,350	8,750	8,150	11,448
3	Net operating income (Rs.)	2,197	3,462	3,122	4,467
4	Capital productivity (Operating ratio)	0.65	0.60	0.62	0.61
5	Labour productivity (kg/crew/trip)	5.00	5.00	4.11	9.41
6	Input-output ratio	0.30	0.20	0.23	0.21
7	Gross value added	4,420	6,949	6,269	9,011
8	GVA as a per cent of gross revenue	69.61	79.42	76.92	78.71

Economic sustainability and trade

Economic performance of non-mechanized fishing methods in Tamil Nadu and Andhra Pradesh

	Economic indicators	SD (Bottom set Gill Net) TN	SD (Other Bottom set Gill Net)-TN	Non-mech Naravala-Andhra Pradesh	Hook and Line Andhra Pradesh
1	Total Operating cost (Rs.)	224	183	7069	2828
2	Gross revenue(Rs.)	551	416	11751	5655
3	Net operating income (Rs.)	327	233	4682	2827
4	Capital productivity (Operating ratio)	0.41	0.44	0.60	0.50
5	Labour productivity (kg/crew/trip)	1.3	4.5	38.00	9.07
6	Input-output ratio	0.10	0.14	0.00	0.00
7	Gross value added	494	357	11704	5655
8	GVA as a per cent of gross revenue	89.66	85.82	99.60	100.00

Economic performance of non-mechanized fishing methods in Odisha

	Economic indicators	Non-mech. *Discovala*	Non-mech. *Gagaravala*	Non-mech. Hook and Line	Non-mech. Gill net
1	Total Operating cost (Rs.)	3632	3802	11580	793
2	Gross revenue(Rs.)	6568	15069	22260	1548
3	Net operating income (Rs.)	2936	11267	10680	755
4	Capital productivity (Operating ratio)	0.55	0.34	0.52	0.51
5	Labour productivity (kg/crew/trip)	3.12	10.50	13.14	11.47
6	Input-output ratio	0.10	0.04	0.04	0.02
7	Gross value added	5897	14369	21400	1510
8	GVA as a per cent of gross revenue	162.36	377.93	184.80	97.55

State-wise average retail Centre price realization across states (in Rs.)

Species	WB	OR	AP	TN	PU	KL	KA	GO	MH	GJ	DD
Penaeid shrimp	499	358	334	400	313	362	380	470	463	352	355
Indian mackerel	195	204	188	250	196	232	240	249	299	239	218
Ribbon fish	164	143	223	140	210	248	271	235	248	202	230
Non-Penaeid shrimp	257	230	243	220	238	228	0	270	321	251	263
Squids	260	232	278	243	236	261	238	213	268	215	282
Oil sardine	110	103	96	150	111	178	178	94	166	109	0

PO- Puduchery, KL- Kerala, KA- Karnataka, Go- Goa, MH- Maharshatra, GJ- Gujarat, DD- Daman and Diu

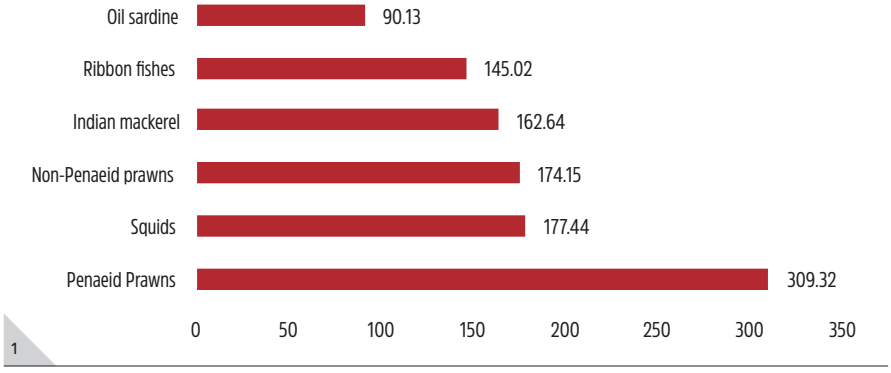
Average Retail Centre Price realization

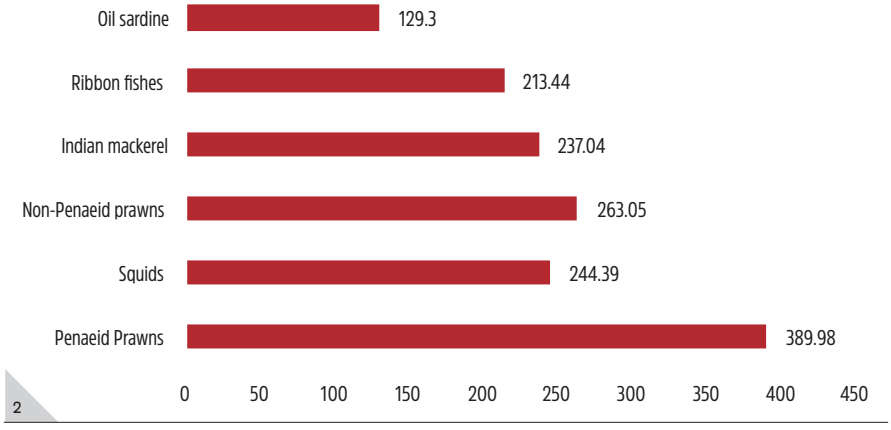
The analysis of average retail Centre prices indicated that Penaeid shrimp realized the realized the highest retail price at Rs.389.98 per kg followed by non-penaeid shrimp Rs.319.34 per Kg, while oil sardines realized prices at Rs.129.30 per kg which is the lowest.

Marine fish market efficiency: Across states and species

Marketing efficiency is measured as the fishermen share of the consumer's rupee

Economic sustainability and trade





1. Species-wise average landing Centre price realization – All India (Rs/kg)
2. Species-wise average retail centre price realization – All India (Rs/kg)
3. State-wise average marine fish marketing efficiency – All India
4. High market efficient species
5. Low market efficient species

State-wise average landing Centre price realization across states (in Rs.)

Species	WB	OR	AP	TN	PU	KL	KA	GO	MH	GJ	DD
Penaeid shrimp	392	238	296	304	250	303	315	376	329	291	304
Indian mackerel	124	134	135	154	155	179	162	164	185	135	140
Ribbon fishes	107	105	143	106	161	165	181	166	172	135	168
Non-Penaeid shrimp	157	124	165	120	127	135	0	185	220	165	175
Squids	158	160	195	167	176	185	198	177	196	155	220
Oil sardine	64	63	54	87	65	98	86	64	91	47	0

(FSCR) across the major species. The analysis of marine fish marketing efficiency across the different states in India indicated that Kerala registered the highest share of consumer rupee at 72.33 per cent and Odisha the lowest at 58.13 per cent. The higher market efficiency indicates that the fishers receive higher share of the consumers price and also the number of intermediaries in this market channel are less.

Across the major species, the marketing efficiency is classified as (i) high market efficient species and (ii) low market efficient species based on the levels of marketing efficiency.

In general the high value species like Penaeid prawns (79.31%), Stolephorous (72.66%), squids (72.60%) and Cuttle fish (72.26%) registered higher marketing efficiencies compared to Croakers, Lizard fishes, Snappers, Scads and oil sardines.

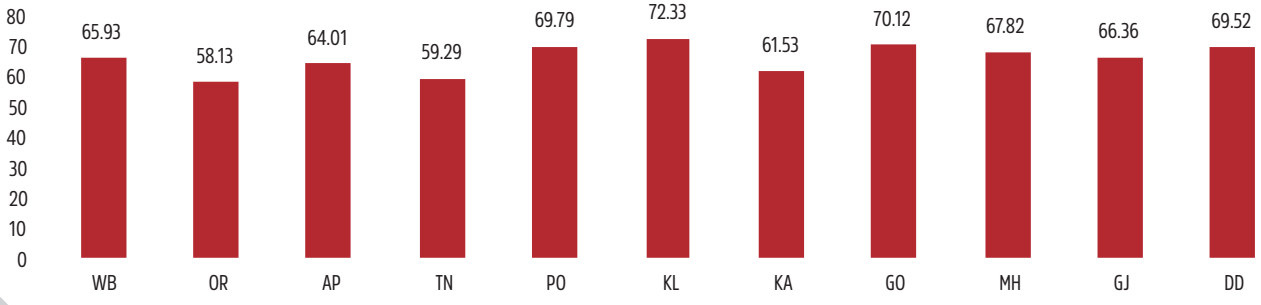
Assessing fish consumption paradigms and spatial demand across India

Understanding fish consumption pattern across India assumes significance to form

Economic sustainability and trade

policies in production, distribution and nutritional security. Results of the studies across the selected coastal states- Kerala, Odisha, Andhra Pradesh, West Bengal and Gujarat (360 respondents) indicated that socio economic variables significantly influenced the fish consumption pattern.

The average monthly per capita fish consumption ranged from 5-10 kg in Odisha and West Bengal to 20-30 kg in Kerala, Gujarat and Andhra Pradesh. The average monthly income of the respondents determines the fish consumption with 30 per cent of the



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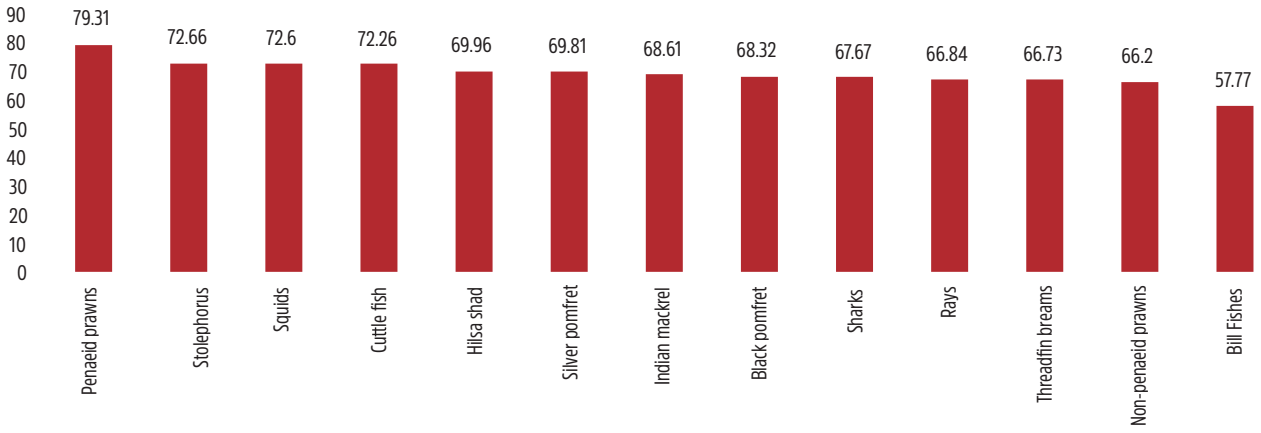

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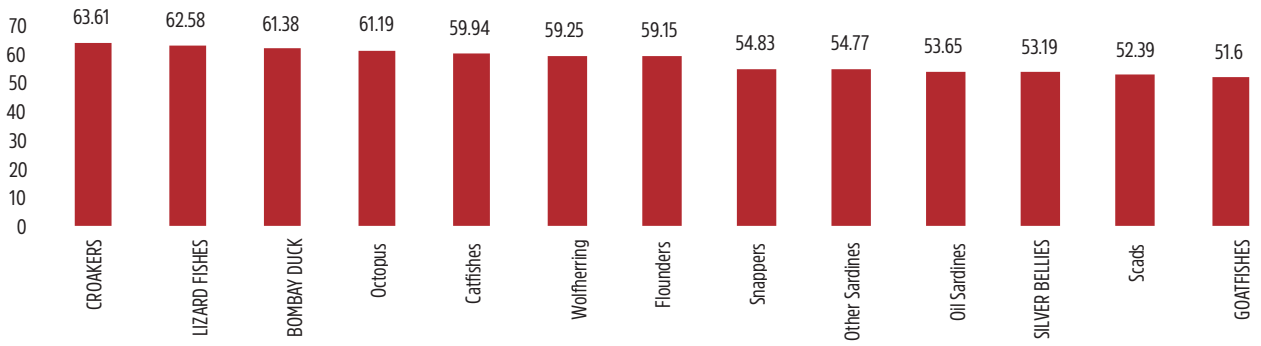

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income is used for purchasing fish in Kerala whereas in Odisha (32%), Andhra Pradesh (25%), West Bengal (38 %) and Gujarat (35 %) respectively. The scenario of fish purchasing behaviour implies that about 40 percent of the total respondents in all the five states buy fish daily and about 62 percent of the respondents in Kerala, Odisha, West Bengal and Andhra Pradesh depend on retail Centre's for purchasing fish. In Gujarat 52 percent of the major respondents purchase fish from the landing Centre's.

The preference indices was developed for the different fish species consumed and it was found that Mackerel remains the most preferred fish in Kerala and Odisha with a high score of 0.58 followed by Sardine (0.56) and Rohu (0.55). In Gujarat, ribbon fish (0.58) and groupers (0.55) were the most preferred fish whereas in Andhra Pradesh it stands for Seer fish (0.59), Threadfin breams (0.56) and Tuna (0.58) were the species with highest preference index. Lack of fresh fish, high price and irregular supply are the major limiting factors in fish consumption.

Economic Recession and Indian Seafood Exports: Reflections and Paradigms

The impacts and aftermaths recession turmoil's in the fisheries sector of India focusing on assessing the export performance, trend and instability of export of both commodity wise and market wise of Indian marine products during the pre-post-recession periods was studied. The results indicated that, amidst the global recession and economic meltdown, the exports were augmented. Frozen shrimp registered the highest growth rate in quantity from 3.15 per cent to 18.95 per cent in the pre- post-recession period. India continues to be the world largest exports of shrimp and economic recession across the world since 2008 hasn't hampered the growth of Indian export and the export trade

Export Growth of Marine Products – Commodity wise

Parameters	Pre-recession	Post-recession
Frozen Shrimp		
Quantity	3.51*	18.95*
Value	4.37*	28.47*
Frozen Fin Fish		
Quantity	4.51**	1.51***
Value	8.26*	10.56*
Frozen Cuttle fish		
Quantity	3.98*	2.82**
Value	9.57*	11.73*
Frozen Squid		
Quantity	1.12***	4.95*
Value	5.76*	16.23*
Others		
Quantity	19.45*	7.94*
Value	19.39*	12.30*

* indicates the significance level if p value < 0.05, ** if p value < 0.01 and *** if p value < 0.001 respectively.

Export Instability of Marine Products – Commodity wise

Parameters	Pre-recession	Post-recession
Frozen Shrimp		
Quantity	5.76	11.28
Value	11.23	25.19
Frozen Fin Fish		
Quantity	37.91	16.41
Value	33.4	16.92
Frozen Cuttle fish		
Quantity	14.12	14.23
Value	17.27	13.09
Frozen Squid		
Quantity	14.9	23.16
Value	15.75	28.95
Others		
Quantity	14.56	11.18
Value	17.54	17.41

The Coppocks instability indices were computed for the two periods and higher instabilities indicated the volatility of the commodities across the time periods

Decomposition Analysis–Commodity wise

Source of Change	Percentage Share			
	Frozen Shrimp	Frozen Fin fish	Frozen cuttle fish	Frozen Squid
Change in Mean Export Quantity (1)	59.83	37.68	39.14	58.85
Change in Mean Export Unit Value (2)	18.96	41.07	41.26	16.91
Interaction b/w changes in (1) and (2	23.1	21.7	19.4	21.7
Change in EQ-EUV covariance	-1.89	0.2	-0.45	-0.74

Decomposition Analysis–Geographic Destination

Source of Change	Percentage Share						
	JAPAN	USA	EU	CHINA	SE	ME	OTHERS
Change in Mean Export Quantity	38.02	-24.10	66.71	118.37	37.40	60.25	35.74
Change in Mean Export Unit Value	61.93	127.79	29.45	-13.95	57.12	34.02	59.50
Interaction between changes in (1) and (2)	0.56	-4.00	3.81	-4.49	5.37	5.72	4.62
Change in EQ-EUV covariance	-0.50	0.31	0.03	0.07	0.11	0.01	0.14

consistently grows around 10-15 per cent during the last decade

E- Marketing Intervention in Indian Fisheries Sector "- develop an integrated fish market and price information systems (FMPIS) for Indian fisheries sector

Research Project: EF20

The E- Marketing Intervention in Indian Fisheries Sector funded by the National Fisheries Development Board (NFDB) aims at ddevelopment a fish market information system (FMIS), developing a price information system (FMPIS) for the traded commercially important fish species and developing a trade facilitating platform (FTP) leading to added fish distribution and consumption utilities across the country

It is proposed to include 1500 fish markets representing the marine and inland sector which includes landing centres, production centres, wholesale and retail markets. In the first phase 500 fish market across 32 states / UTs will be identified for the development of a full fledge FMPIS. These 500 markets include landing Centres (12%), production centres (12%), wholesale market (24%) and retail Market (52%) respectively. A field manual on commercially traded fishes of India was finalized with 150 marine and inland fish species was developed.

Global understanding and learning for local solutions: Reducing vulnerability of marine- dependent coastal communities (GULLS)

Research Project: EF6

Socio Economic Vulnerability assessment

Socio Economic Vulnerability assessment – Coastal Vulnerability Index (composite of sensitivity index, exposure index, and the adaptive capacity index) was calculated for the identified marine hotspots of India, viz, at Ramanathapuram district in Tamil Nadu.

Assessing the alternative livelihood options (ALOs) for climate change vulnerable coastal fishing villages in Kerala

The need for ALOs consequent to the impact of climate change on fisheries

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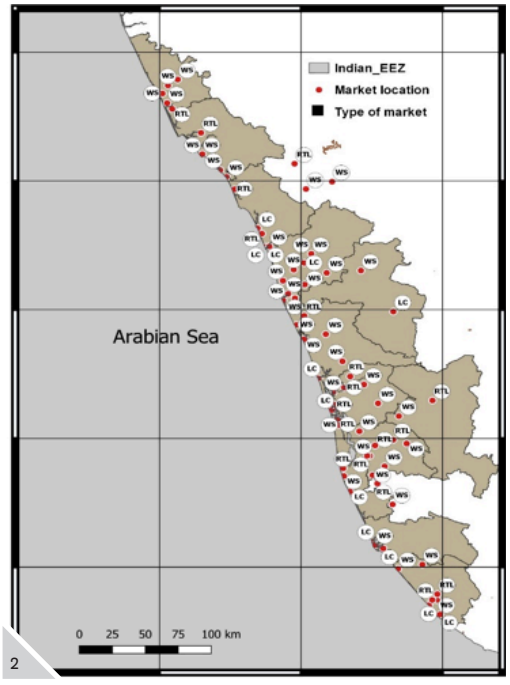

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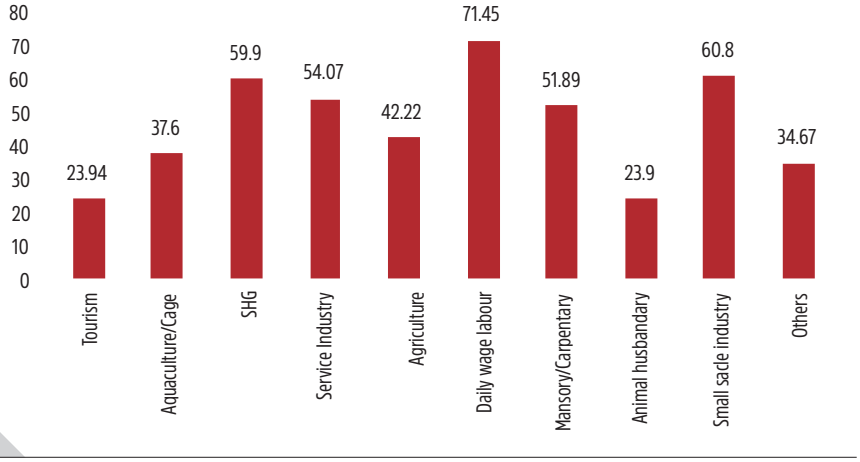
1. Interacting with the fishermen in the market
2. Identified fish markets of Kerala
3. Preferred Alternative livelihood options
4. Suggestions for mitigating flood in future

Economic sustainability and trade

and its resultant impact on the livelihood of fisheries dependent communities was assessed across 1259 households from Poonthura and Elamkunnapuzha. It was found that 69.52 % required alternative livelihood options supports. The alternative livelihood means include daily wages jobs, service industry, small scale industries etc. Coastal communities (75.95 %) are willing to participate in adaptation and mitigation programmes against climate change.

Impulse effect of the flood on the livelihoods of Marine fishers in Kerala

An assessment was done (100 respondents) on the Impulse effect of the 2018 August flood on the livelihoods of marine fishers in Kerala leading livelihood loss of fishermen incurring damage to craft, gear and other fishing accessories. At macro level the total loss was estimated at about Rs 6.72 crores in inland fisheries sector and Rs 4.24 crores in the marine sector The results reveals that fishers lost an average of 2-4 weeks employment days due to flood and alternative livelihood options of the fishermen have also been crashed with the highest average loss incurred for fish farming (45.45%). Amidst these losses the fishers were the real super heroes during the flood with huge involvement in the rescue operationsacross the different flood affected areas such as Puthuvype, Elamkunnapuzha, Vypin, Edavanakkad and Nayarambalam.



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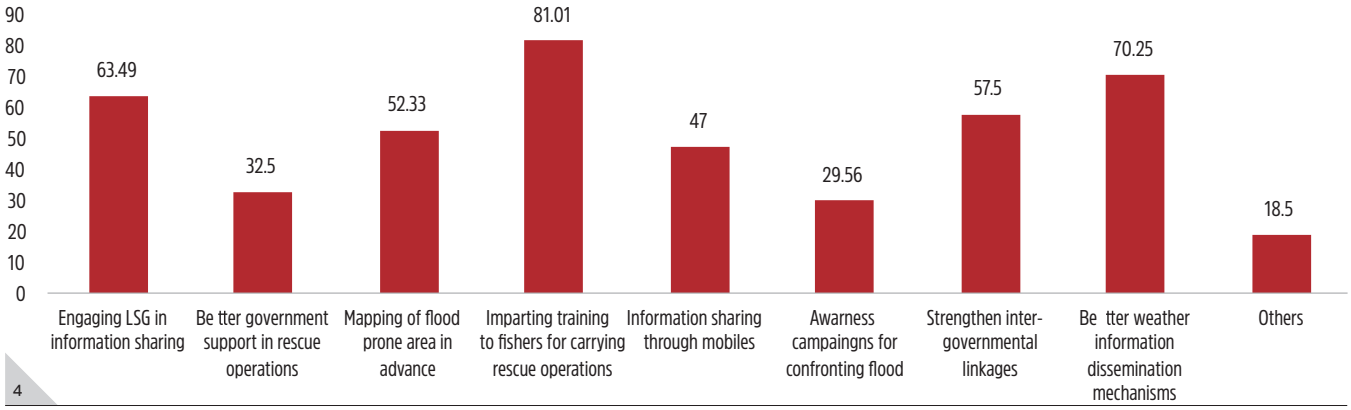
Identification of climate change agents

For the proactive planning and development of climate change adaptation and mitigation plan the project has identified the climate change agents who could champion the cause of climate change resilience plan and programme

In order to curb climate change CReVAMP' – "Climate Resilient Village Adaptation and Mitigation Plan was developed



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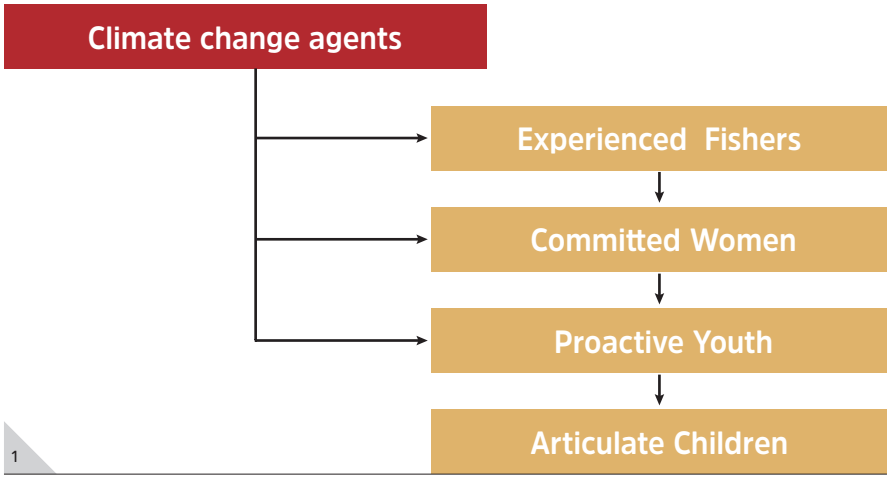

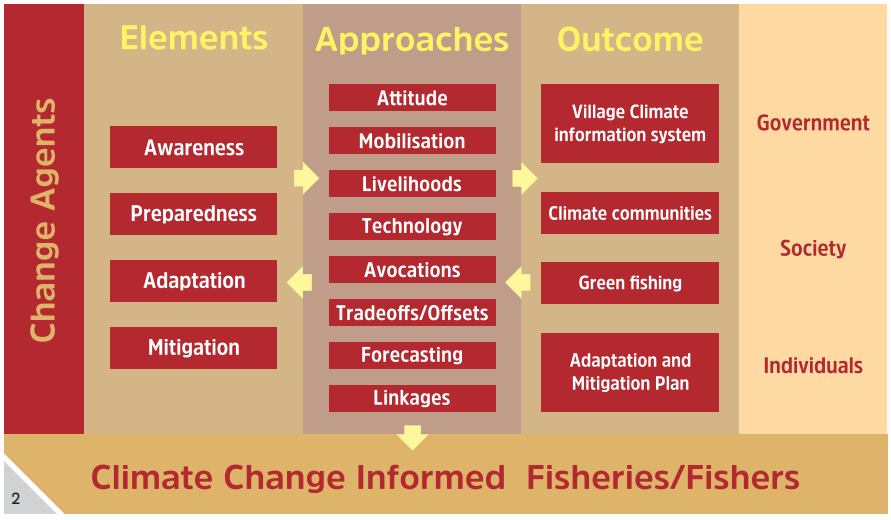

1. Climate Agents
2. Cre Vamp Framework model
3. Stakeholders consultations and engagements in combating climate change

for and implementing village level adaption and mitigation plan through sensitizing and improving the resilience of community towards climate change and initiating a multi stakeholders platform for developing a climate knowledge and information systems;"

Zonal wise vulnerability assessment- Sea mice model

Zonal wise vulnerability assessment of different species was carried out. For the preparation of vulnerability matrix, climatic variables (exposure attributes) were given more weightage as the sensitivity traits are dependent on changes in the climatic variables. Vulnerability score of <1 was considered as low vulnerability, 1.0-1.5 as medium and >1.5 as highly vulnerable. Vulnerability matrix for different geographical zones was generated by plotting impact versus vulnerability score. The ranking of climate vulnerability tend towards moderate vulnerability, with a scoring range of 1.33-1.73.The anomalies of climate variabilities were moderated in South west zone. Climate exposure ranking of pelagic species was comparatively higher than that of demersal species. Impact, an additive index of exposure and sensitivity attributes, was classified into high, medium and low for the 68 species assessed for vulnerability. The climatic variability score was medium in south west zone. Overall 30% of the species studied ranked medium in sensitivity attributes and 30% of the species are highly vulnerable to climate change. Black Pomfret (*Parastromateus niger*)

Economic sustainability and trade

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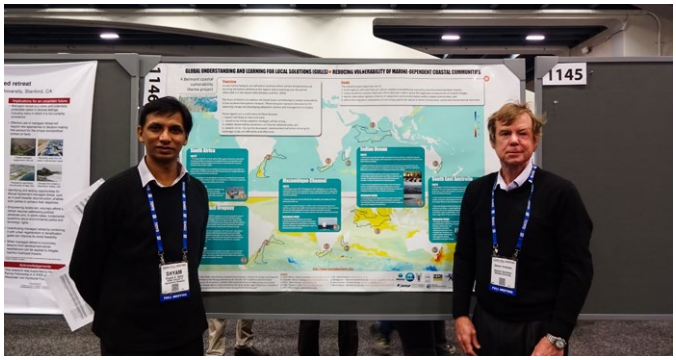


was assessed as highly vulnerable in the southwest. The Sea Mice model was fitted for the catch, biomass and CPUE for oil sardine, mackerel and ribbon fish.

Sea Mice Model fitted for Oil sardine biomass & CPUE

An ecological risk assessment framework to assess the relative sensitivities of commercial species to climate change drivers, specifically in relation to their distribution, abundance and phenology, was demonstrated using 36 key species based on literature collection, expert judgment with data scoring guidelines was attempted. The sensitivity rank of the major species based on the relative scores was worked out. The vulnerability scoring of major commercial important species in the south west zone were plotted against a vulnerability-impact matrix and were ranked as high, moderate and low

Communication

Painting competitions were held for school children to assess their understanding on climate change and its impacts.

Fisheries Governance Livelihood and Gender Welfare

Responsible marine fisheries governance: Compliance analysis and peripatetic capacity development

Research Project: (SEE/GOV/34)

The Malayalam translated version of KMFR Rules 2018 was prepared in association with Department of Fisheries, Govt. of kerala. It was released by Hon. Chief Minister of Kerala Shri Pinarayi Vijayan, during Southern Fisheries Ministers Conference held during 10-11 November, 2018 at ICAR- CMFRI, Kochi.

2

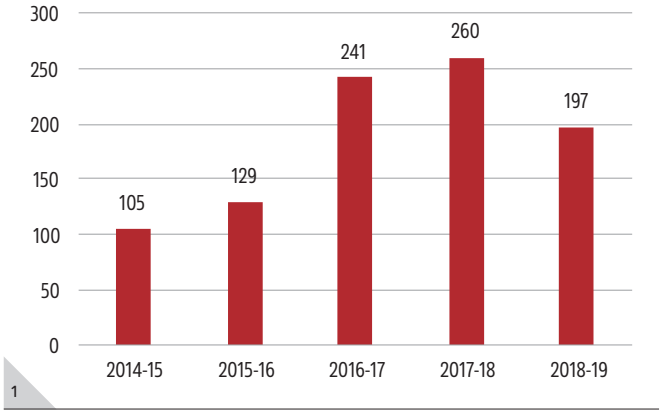
1. Hon. Chief Minister of Kerala Shri Pinarayi Vijayan, is releasing the Malayalam translated version of KMFR Rules 2018
2. Hon. Fisheries Minister of Kerala, Smt. J, Mercykutty Amma, receiving a copy of Malayalam translated version of KMFR Rules 2018 form Dr.Joykrushna Jena, Deputy Director General (Fisheries Science), ICAR. Also seen Dr. A. Gopalakrishnan (Director, CMFRI) Dr. C. Ramachandran and Dr. Reshma Gills

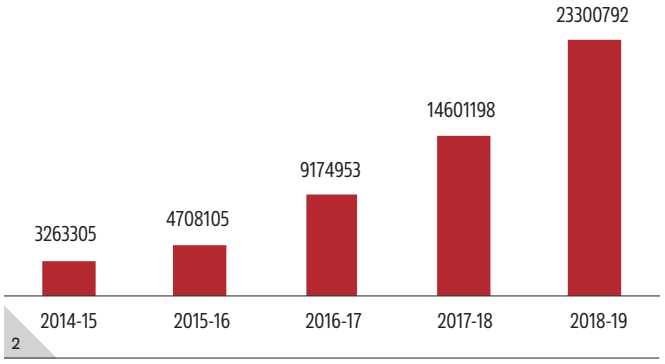
Among the three different extension material formats pilot tested for the preparation of the Malayalam translated version of KMFR Act 2017 (Pamphlet, Folder and Newspaper) *Newspaper* format has been selected based on the results of the experimental analysis done with a sample of 30 stakeholders with respect to the acceptability of the forms among them. Four different criteria has used for this measurement purpose. Newspaper format was selected because it has got maximum percentage of acceptance with respect to all the parameters (Readability (46.67%), Attractiveness (56.67%), Brevity (36.67%) and Ease of handling and retrieval (56.67%).

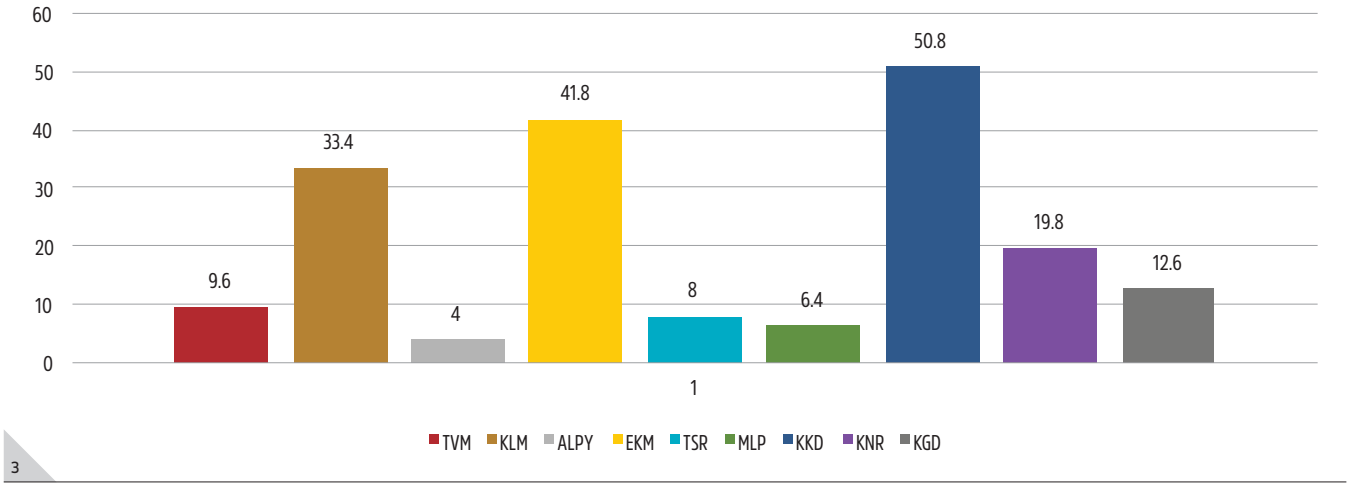
Knowledge level of different functionaries like Sub Inspector of Fisheries, Research Assistants, Extension Officers and Assistant Extension Officers on various rules and regulations of marine fisheries management like FAO CCRF, KMFRA (1980), KMFR Rules 2018 and ability to identify juvenile fishes for MLS were tested. Test results showed significant level of knowledge variation among different group of functionaries in all three regulations aspects except KMFRA (1980). Fisheries Extension officers showed higher level of knowledge about the all-important marine fishing rules and regulations as compared to other functionaries. Contrary to the hypothesis, expected knowledge level of the Sub Inspector of Fisheries who actually are the major arm to deliver the technological and legal know-how and do- how to the fisherfolk were found low on the various fisheries' regulatory mechanisms. It highlighted the need of proper knowledge inducive training and contact lessons for them to reap the intended level of compliance from the fisherfolk.

Impact of the enforcement was analyzed with respect to the number of impounding reported and the revenue generated by the Department of Fisheries, Govt. of Kerala during 2014-15 to 2018-19.

District wise average impounding reported for the last five years showed that maximum number of impounding was reported in Kozhikode district with a five-year average of 51 and which was followed by Ernakulam (42).





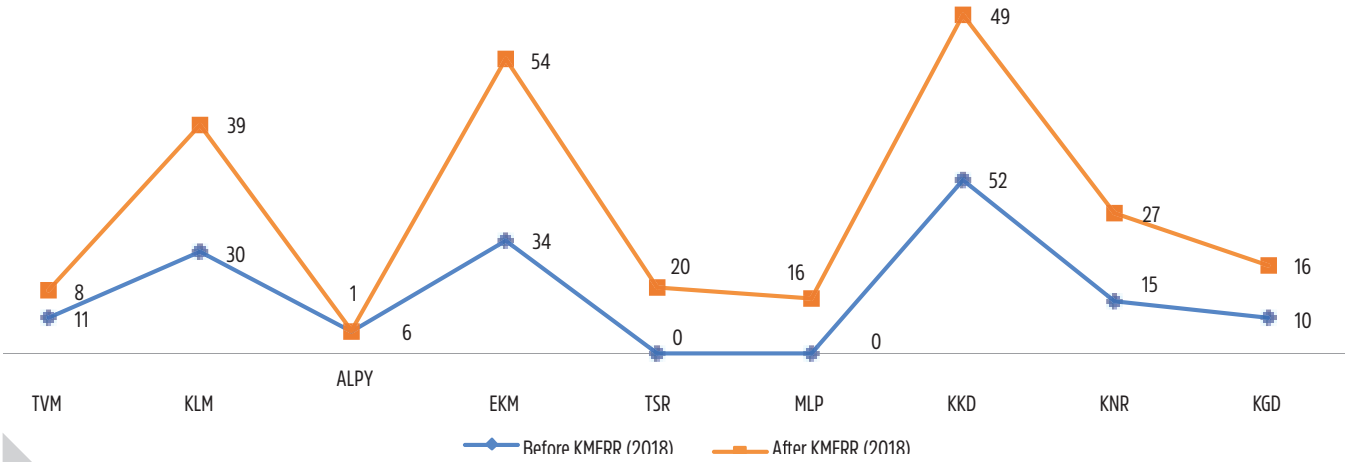


Impact of the KMFR Rules 2018 has been patterned by analyzing the average number of the impounding reported before and after the existence of the rule. It was quite interesting to notice that the number of impounding reported had increased in all the coastal districts except for Kozhikode (Before, 52 and After, 49) and Alappuzha (Before, 6 and After, 1).

It could be surmised from the results that the changes in number of impounding reported in the costal districts may be due to various positive or negative factors like the active and vigilant monitoring of the State fisheries enforcement wing after the implementation of KMFR Rules 2018, social capital-led enhanced level of compliance from the fisherfolks, political meddling etc.

Credit transactions of small-scale ring seine fishers in Kerala

Informal financial agents such as auctioneers and third-party share-holders were found to have a conspicuous presence in the study area.



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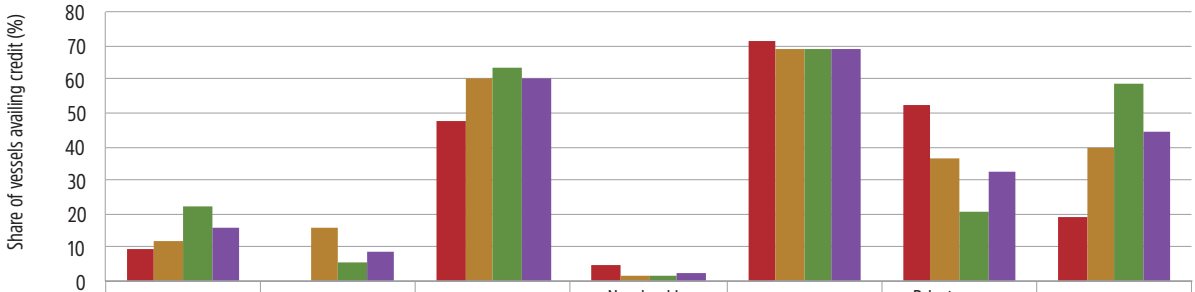


	Commercial bank	Co-operative bank	Matsyafed	Non-banking entities	Auctioneer	Private money lender	Third-party share
Small	9.52	0	47.62	4.76	71.43	52.38	19.05
Medium	12.07	15.52	60.35	1.72	68.97	36.21	39.66
Large	22.41	5.17	63.79	1.72	68.97	20.69	58.62
All	16.06	8.76	59.85	2.19	69.34	32.12	44.54

5

1. No of impounding reported from Kerala
2. Total revenue (in Rupees) generated by reported impounding
3. District wise average impounding reported
4. Average number of impounding reported before and after KMFR Rules 2018
5. Borrowing behaviour of sample ring seine vessels by source (%)

It was found that the traditional quasi-credit, inter-linked market-tying deals between auctioneers and fishermen, still continue to be a dominant mode of informal lending.

Auctioneers catered to the credit requirements of about 69 per cent of fishing units surveyed, while the private money lenders served 32 per cent. The presence of Matsyafed was conspicuous with coverage of 60 per cent lending across the surveyed units.

A detailed analysis based on fractional regression modeling of the fishery credit transactions in Kerala showed that borrowing from institutional sources is found to intensify with increase in size of fishing units thereby suggesting that smaller vessels tend to depend more on informal lending sources. Similarly, fishing

units operated by experienced skippers are found to rely more on institutional sources, thus hinting the role of steady revenues in the demand for formal finance.

Labour Mobility in harvest sector

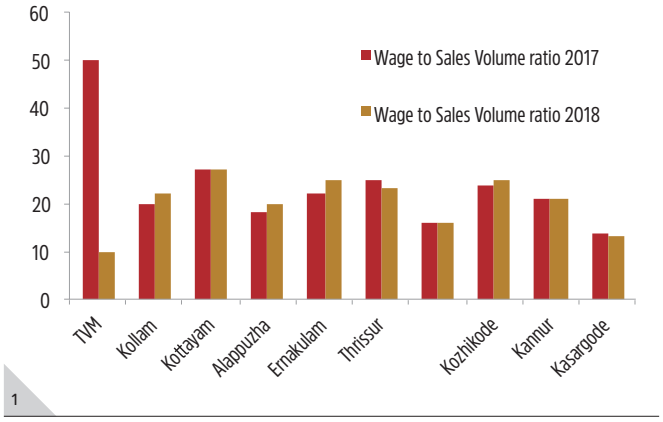
Labour limits fishing operation resulting in huge labour mobility influx from different coastal and non-coastal states. The study conducted across Gujarat and Maharashtra revealed that the prime reasons for migration included low income, debts, financial commitments and disguised unemployment. The mobility augmented income besides increased savings, construction of house and possession of personal assets along with social status elevation to them. The major problems confronted during migration are the language barrier, cultural lag and competition with established migrant labour.

Assessing the financial viability of *Theeramythri* enterprises

Project code: 1010080

The sustainability of *Theeramythri* enterprises were determined using Benefit Monitoring and Evaluation matrices which included asset ratio, wage rates realised and average employment days across the different districts and sectors.

Stakeholder's conclaves for the different kinds of technical, socio-economic, value addition, credit and marketing intervention required for the *Theeramythri* activity groups were conducted in Kasargod, Kannur and Kozhikode districts with more than 100 group members and the recommendations were to be implemented by the District Nodal officer, SAF.



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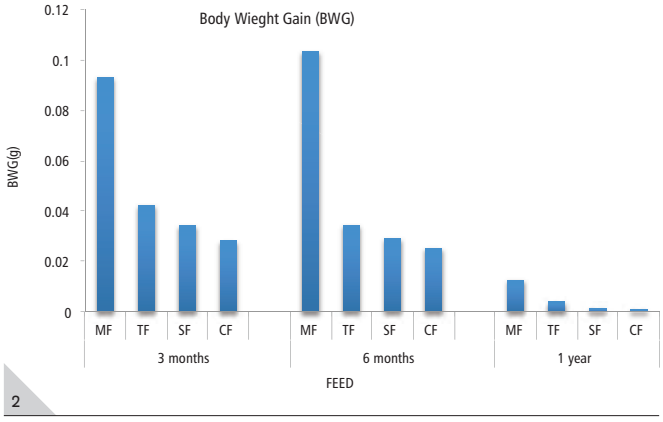

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Theeranaipunya IV- Gender mainstreaming through skill enhancement amongst fisher youth

38 young educated fisherwomen were provided training Among the trainees 14 trainees got contract placements with different governmental and private establishments (Figure 6,7)

1. The wage realization ratio indicting the percentage of wages realized to the total sales turn over across the districts
2. The wage realization ratio indicting the the percentage of wages realised to the total sales turn over across the sectors

3 & 4. Theeranaipunya – IV Training sessions

Fishers' welfare impact assessment on the satellite based ocean information services

Project code: 1010246

The project attempts to gauge the extent of adoption of information services and realizes correlation with the socio-economic attributes of the stakeholders, evaluating the impact of information services on the fishers' welfare. The assessments cover around 4500 respondents across pan India representing samples from three different fisheries sectors.

Fishers' welfare gains were studied as the economic gains obtained from the Potential Fishing Zone. Table represents the variables studied across the two-time scales and the economic gains realized from the PFZ.

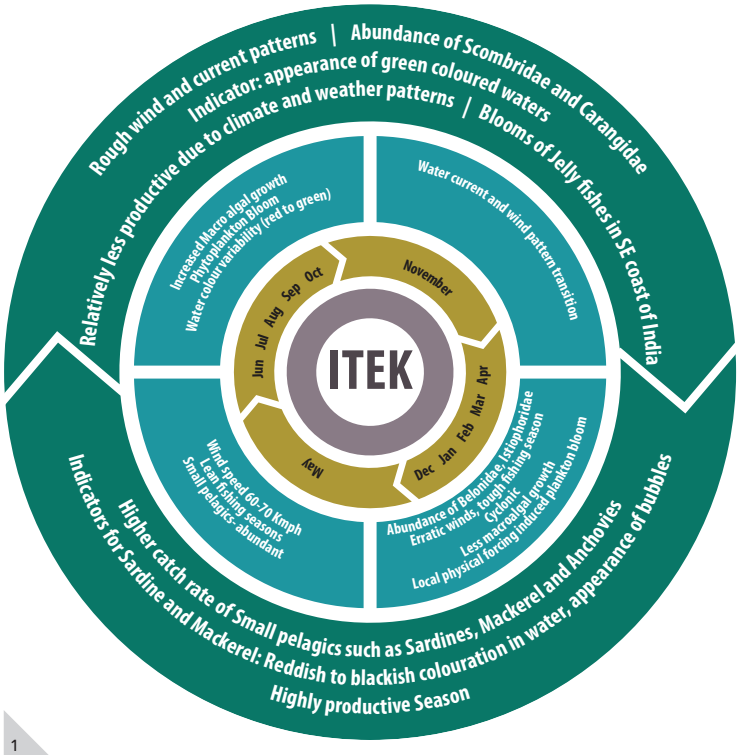

3


4

Economic gains from PFZ Advisories

Parameters	Pre PFZ	Post PFZ	Incremental
Catch/ Trip/tonne	1.42	1.54	8.45
Average Price (Rs/kg)	148	152	2.70
Revenue (lakhs)	2.10	2.34	11.43
Cost (lakhs)	1.67	1.74	3.97
Fuel (lakhs)	0.92	0.87	-5.48
Operating Ratios	0.796	0.74	-6.78
Profit (lakhs)	0.43	0.60	40.40
Added Revenue	0.24		
Added Cost	-0.07		
Net Gains	0.17		

Fisheries Governance Livelihood and Gender Welfare



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1. Seasonal ecological calendar framework for Tamil Nadu
2. Seasonal ecological calendar based on integration of ITEKs
3. Map showing the diversified livelihoods in Ramanathapuram district Tamil Nadu

Seasonal Variability	Northeast (winter) monsoon					Transition	Southwest (summer) monsoon					Transition
Months	December	January	February	March	April	May	June	July	August	September	October	November
Winds[21]	VaadaiKaatru–Abundance of Kilichaimeen, Mayilmeen (Carangidae, Istiophoridae/Xiphidae)				ChozhaKachaan KachaanKaathu–wind speed (60-80 kmph); ChozhaKondal–Indicator of Choorai (Tuna), Keerai (Yellow Fin Tuna)			ChozhaKondal			KondalKaatru; VaadaiKaatru VaadaiKaatru	
Ocean currents[21]	Vaadai Neerottam–Murrel season (Belonidae abundance)				Chozha Neerottam–Lean Fishing Season							Vaadai Neerottam
			Kondal Neerottam–Abundance of many fish species				Kachaan Neerottam–Tough fishing season					
Water colour[18]		RathaKraipu (Red colour) / Kalanguthanni–Indicator of Sardines, Anchovies and Carangids					PachaiKraipu (Green colour)–Indicator of Scombridae and Beloniformes					
Macroalgae	*Padina & Gracilaria* sp.–Lesser diversity reported[34,35]						*Padina, Gracilaria* & *Ulva* sp.–Higher diversity was reported in this season					
Seagrass	Presence of *Halophila ovalis* ("Saethupasi") patches are perceived as dark muddy zones, indicator for fishing shrimps, crabs and fishes whereas, presence of *Halophila ovata* ("Pottalpasi"), Pottal means clear water zones which has less fish population and not suitable for fishing26						Increased growth of dominant seagrass species such as *Cymodocea serrulata* and *Syringodium oestifolium* were observed in the monsoon season, due to optimum temperature, low salinity, pH and addition of nutrients (indicator of healthy spawning, breeding and feeding grounds of marine fishes and mammals)[36].					
Sea birds							Shearwater flocks–indicator of Sardines and Anchovies; Terns–indicator of shrimp species *Fenneropenaeus indicus* and *Metapenaeus dobsoni*[37]					
Phytoplankton							Diatom blooms during upwelling, change in water colour–indicator for abundance of pelagic fishes such as Sardines and Mackerel[38,39]					

2

Integration of indigenous traditional knowledge to the scientific forecast

A skeletal framework of seasonal ecological calendar for the Tamil Nadu coastline was developed. This context will enable us to conserve these ITEKs sustainably and we can also build the scientific and technological contributions with more outreach and efficacy.

Diversified livelihood options and gender mainstreaming

Research Project: (SEE/GEN/36)

From Gujarat, Gir Somnath district, from Maharashtra the districts of Sindhudurg, Mumbai and from Tamil Nadu Ramanathapuram district were selected for the study. In Gir Somnath district of Gujarat,the Diversified livelihoods (DLOs) of fishers from Dhari, Bhidia and Veraval were documented. It could be observed from the Table that owners of shrimp farm enterprises have the highest mean annual income of Rs. 5,00,000 followed by middle men in fish marketing i.e., Rs.3,85,180.

Diversified livelihoods and mean annual income of fishers in secondary sector, Gir and Somnath district, Gujarat

DLOs	Enterprise	Nos	Mandays	Mean Annual Income from DLOs. (Rs.)
Fishery Related	Labourer in Harbour	10,000	351	1,86,000
	Labourers+Fish Vendors	2000	280 (168+112)	1,80,000 (1,40,000+40,000)
	Labourer +Account Keeping in Fish Purchase	800	365 (281+84)	1,65,000 (1,20,000+45,000)
	Middle man in Fish marketing	250	315	3,85,180
	Labourer +Rickshaw drivers	150	316 (204+112)	2,00,000 (1,50,000+50,000)
	Labourer in Ice crushing	300	320	2,71,660
	Shrimp farming (owner)	165	157	5,00,000
	Shrimp farm labourer	660	225	72,000

In Ramanathapuram district, 16 diversified livelihood enterprises were identified and studied.

Cage Farming

Main Occupation -Single Day Mechanized Trawl Fishing, Owner: Mean Annual Income/fisher was Rs. 20,00,000, 110 mandays

Type of DLO	Enterprise	Additional mandays	Income from DLO (Rs.)	% Increase in Annual income
Fishery Related	Sea Cage Farming (2 cages/fisher)	120	4,00,000	20.00

Marine Ornamental Fish Culture

Main Occupation -Single day mechanized trawl crew member, mean Annual income/fisher: Rs. 2,00,000, 110 mandays

Type of DLO	Enterprise	Additional mandays	Income from DLO (Rs.)	% Increase in Annual income
Fishery Related	Marine Ornamental Fish Culture	90	1,50,000	75

Jasmine cultivation and garment making unit

DLO's	Enterprise	Additional mandays	Income from DLO (Rs.)
Non-Fishery Related	Jasmine Cultivation	206	1,80,000
	Garment making Unit	160	36,000

It was interesting to observe that among the standalone enterprises jasmine cultivation fetched the highest mean annual income of Rs. 1,80,000.

On the basis of impact study on 300 'Self Help Groups' in Gender mainstreaming in marine fisheries sector, assessed the level of performance and extent of empowerment through appropriate indices of measurement from Kerala, Tamil Nadu, Andhra Pradesh and Odisha were assessed. Identified the relevant fishery based micro enterprises catering to the location specific needs of the SHG members and imparted 32 Entrepreneurial Capacity Building (ECB) Training programmes and undertook 40 fisherfolk interaction meets.

Done the Economic Feasibility analysis of 16 microenterprises accomplished by SHGs and developed Business Plans of the microenterprises such as Aquaponics, Ornamental fish culture, Dry fish units, cage farming in Vembanadu lake, Fish Marketing, Clam collecting etc. Done the constraint analysis of SHGs of women fisherfolk in fish processing, cage farming and clam processing through Fieldman's Rank Test.

Similarly, in Kavaratti island of Lakshadweep, the constraint analysis of

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1 &2. Organized '*Mahila Kisan Diwas*' by mobilizing 83 women SHG members under the project at ICAR-CMFRI Kochi on 15th October, 2018

3-5. Microenterprises (Aquaponics, Dry fish unit & Shrimp Processing Unit)

women SHG members on enterprises like Tuna *massmin* flakes preparation, value added and processed fish products & coconut based products was undertaken with the Friedman's Rank Test. Brought out 9 documentaries and documentaries on 'Clam Processing SHGs' and 'Bivalve farming SHGs' were shortlisted in the 'Women in the seafood industry' video contest, developed by the International Organisation for Women in the Seafood Industry (WSI), with the support of AFD French Development Agency and Matis Icelandic R&D company.

Agricultural Technology Information Centre (ATIC)

Technology advisory services

Technology advisory services were provided to 13,600 visitors in the institute, 1050 people through telephonic contacts/ emails and another 8,000 people through exhibitions as well as training programmes during 2018-19. The annual revenue generated during 2018-19 through sale of institute technology products and visitor's fee collection was Rs.5.78 lakhs.

Trainings and Exhibitions

1. ATIC along with KVK of CMFRI coordinated the interactive meeting with Western Sydney University (WSU) team at CMFRI, Kochi on 4th December, 2018.

Revenue generation through ATIC

Item	(Rs.)
VARNA Feed	369300
Posters	18150
ICAR Publications	———-
CDs	550
Ornamental Fish seed	10230
Rotifer/Algae/Zoo plankton	4870
PCR / analytical tests	35940
Others	9379
Visitors fee	129680
Total	578099

1

2. Two On-the-job (OJT) training programmes on “Advances in mariculture techniques” were conducted for the Fisheries vocational higher secondary students through ATIC from 24/09/18 to 29/09/18 and from 10.18 to 25.10.18.

3. One day training programme on 5th February, 2019 and Motivational visit and student-scientist interactive session under the walk with the scholar programme on 22th February, 2019 for the students of St. Michel’s college, Chertala.

4. Organized exhibition in connection with National Conference on Marine Debris (CoMaD 2018) from 11 to 12 April 2018.

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1. Interactive meeting with Western Sydney University Team at CMFRI, Kochi

2 &3 VHSE student receiving certificates after on-the-job training programme

4 Training programme conducted in connection with world wetlands day

4

Institute Technology Management Unit

Patents ensure property rights (legal title) for the invention for which patent have been granted, which may be extremely valuable to an individual or an institution. The patents are being filed through ITMU (Intellectual Property Management and Technology Transfer/ Commercialization Unit). All action pertains to the filing of IPR applications and their follow up under the law including maintenance of IPR, and further management of IP, is being undertaken by ITMU of Central Marine Fisheries Research Institute.

Institute Technology Management Unit

Commercialization of Technologies during 2018-2019

Name of Technology/ Know-how	Name of Contracting Party	Mode of Patnership	Date of Licensing	Revenue Earned (Rs.)
Varsha-Ornamental fish feed	Taiyo Feed Mill Pvt. Ltd.,17A, South Mada Street, Kolathur, Chennai-600099, Tamil Nadu (a leading Indian feed manufacturing company in India)	MoU (Licensing and royalty)	28/08/2018	Rs. 1.5 lakh as license fee and 2% royalty
CadalminTM Antihypercholesterolemic extract (CadalminTM ACe) to combat dyslipidemia and obesity from seaweeds	Vandana Luthra Curles and Curves (VLCC) Health Care Limited, a leading Indian MNC in wellness and obesity management	MoU (Licensing and royalty)	29/11/2018	Rs 7.10 lakhs as license fee and 5% royalty

1. hypoglycaemic disorders following oral administration at a dose as high as 2 x 103 mg/kg/d. Earlier, the product was released by the Hon'ble Union Minister of Agriculture, Shri Radha Mohan Singh.

Varsha-freshwater ornamental fish feed (FWOFF) is scientifically developed and coded based on sizes 1mm and 2 mm and protein content 25, 30, 35, 40 and 45% as CMFRI FWOFF 125, 225, 130, 230, 135, 235, 140, 240, 145 and 245. The freshwater fish feed product "Varsha" contains a high quality marine protein mixture (fish, shrimp, squid and clam), soy, wheat, fish oil, vitamins, minerals, spirulina, mixed carotenoids, anti-oxidants and anti-fungal The directions to use are to feed approximately 2-3% of the body weight. This feed is the import substitute of the commercially available products. The technology has been licensed to Taiyo Feed Mill Pvt. Ltd., Chennai.

Cadalmin™ ATe is a nutraceutical product, which provides a unique blend of 100% natural marine bioactive ingredients with anti-thypothyroidism principles extracted from seaweed, with an ecofriendly "green" technology. The bioactive leads concentrated in Cadalmin™ ATe were found to stimulate thyroid releasing hormone and increase the activity of selenodeiodinase to produce metabolically active thyroid hormones tetraiodothyronine and 3, 5, 3'-triiodothyronine. Preclinical trials showed no toxicity related significant changes in vital organs. The results also demonstrated a lack of test substance-related general organ or systemic toxicity and hypoglycaemic disorders following oral administration at a dose as high as 2 x 103 mg/kg/d. Earlier, the product was released by the Hon'ble Union Minister of Agriculture, Shri Radha Mohan Singh.

Management of IP portfolio

Response towards the FER has been filed for 4254/DEL/2015 in respect of "Anti-inflammatory principles in a preparation of brown seaweeds" with prior intimation of NBA, Chennai.

India is a member of the World Trade Organization, and therefore, must comply with the TRIPS Agreement since 1st January 1995. IPRs are primarily important because they offer mechanisms to stimulate R & D keeping in mind the practical applications, and therefore, ultimately benefit the end users. Patents ensure property rights (legal title) for the invention for which patent have been granted, which may be extremely valuable to an institution. Commercialization of IPR enabled technologies and other expertise, through public-private partnership, would lead to their accelerated and efficient transfer. The adoption of IP protected technologies by producers will lead to increase in productivity, production, farmers' income and employment.

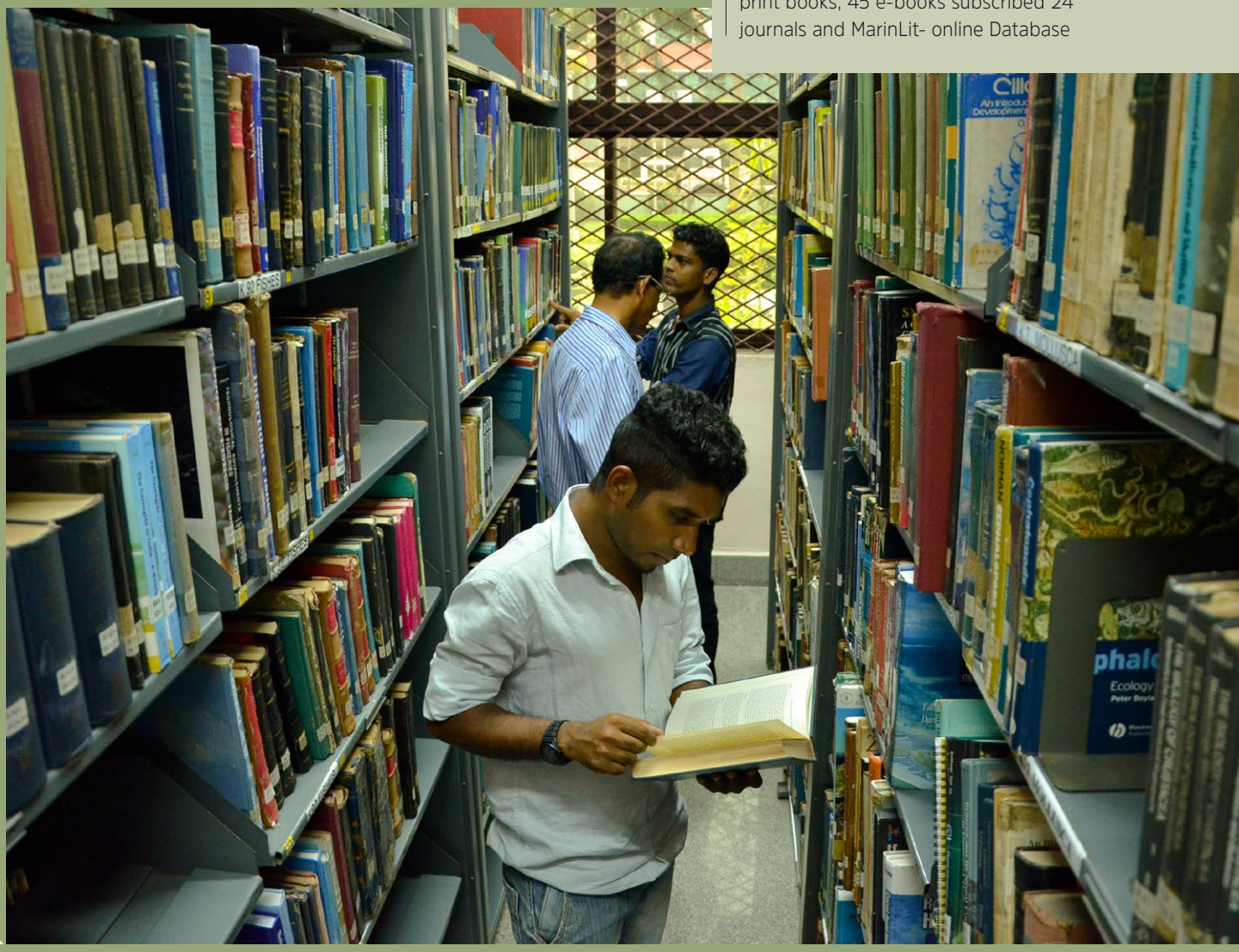
Patents Granted during 2018-19

Patent No.	Title of the Patent
Patent Number 294451	A process to prepare antioxidant and anti-inflammatory concentrates from seaweeds and a product thereof
Patent Number :302803	A process to concentrate anti-inflammatory principles from green mussel *Perna viridis L*.
Patent Number :303813	A product containing anti-inflammatory principles from green mussel *Perna viridis*
Patent Appl. No. 32/CHE/2010 (awaiting NBA approval)	Formulated feed for marine ornamental fishes and a process thereof

FER Filed during 2018-19:

Library and Documentation Centre

Library and Documentation Centre of CMFRI is one among the best-specialised state of the art libraries in the field of fisheries, aquaculture and marine sciences. Library plays an important role in the research activities of the Institute by providing literatures and services to the staff and scholars at HQ as well as RCs. Students and researchers from Universities, Colleges, State Fisheries Departments, and other Institutions utilise CMFRI library for their academic and research purposes. Library purchased 95 print books, 45 e-books subscribed 24 journals and MarinLit- online Database



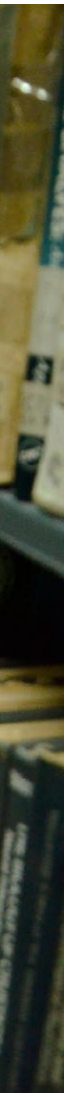
1

Library and Documentation Centre

on Marine Natural Products and 650 issues of current periodicals were added to library stock during 2018-19. Library collection includes Books, Bound Journals, Current periodicals, Reports, Maps, Theses, Dissertations, Posters, CD ROMS, Videos.

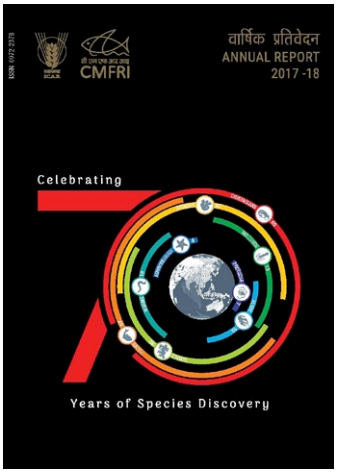
Digital Library

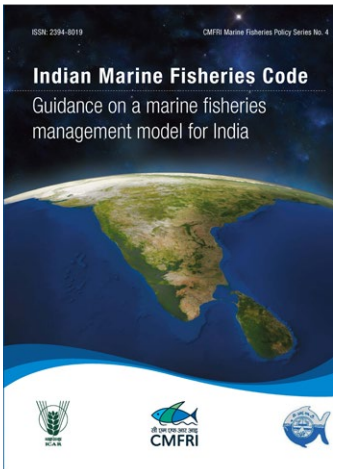
The digital library of CMFRI named 'Library and Publications' is hosted in the Institute website to extend the digital services. All digital services are accessible at HQ as well as RCs. The Library Catalogue, OPAC can be accessed globally for searching the documents available in the library. 78 online journals,2 online databases (MarinLit and IndiaAgristat.com) and 252 open access journals on fisheries and allied subjects are accessible. CeRA subscribed e-journals are made available through J-Gate platform. Access to 1174 e-books on agriculture and allied subjects and more than 3,500 e- journals are available through CeRA. 80 e-books on fish and fisheries,17 e-book series and e-journals on fish and fisheries published by Elsevier, Wiley, Springer, Taylor & Francis are accessible at HQ and RCs.



1. Overview of library
2. Website Library and Publications
3. Eprints_Homepage
4. Publications

Library and Documentation Centre





Institutional Repository 'eprints@cmfri'

'eprints@cmfri' is the open access Institutional repository developed and hosted in the Institute website for archiving the Intellectual products created by CMFRI. Institutional Repository has a total collection of 12,396 publications now. During the period 1,004 new publications were added during 2018-19.

DSpace@CMFRI

"DSpace@CMFRI" is the digital archive of CMFRI developed for archiving Rare and old publications from the year 1800s available in CMFRI. Six thousand old and rare documents like Memoirs, Catalogues, Reports and Expedition Reports are archived in "DSpace@CMFRI". The documents can be searched by Author, Subject, Keyword and Year of publication. Full text of the documents can be accessed at HQ and RCs of CMFRI.

Current Awareness Service

Library compiles the digital magazine "Current Awareness Service" with content pages of new journals received in library and accessible at HQ and Regional/ Research Centres through intranet.

Online Library Information Service

Online Informations on release of new CMFRI publications, Institute publications, activation of online databases and journals, new books purchased etc. were sent regularly to scientists & researchers in HQ and RCs by email.

Online Document Delivery Service

Online requests are received from users of Institutional Repository and users of ICAR-CeRA for full text articles published by CMFRI scientists. Library delivered 392 articles online during the period.

Newspaper clippings

News clippings on fisheries, aquaculture and related subjects published in various newspapers were collected and compiled on monthly basis as News Clippings magazine for reference. Links to online news clippings were provided in the digital library.

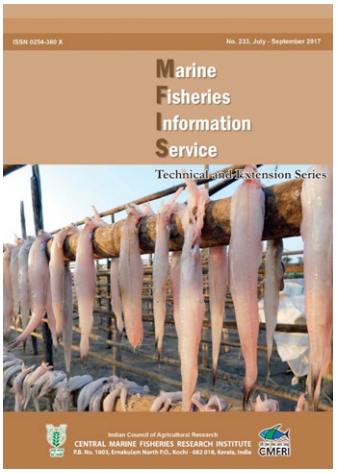
Scanning and digitisation

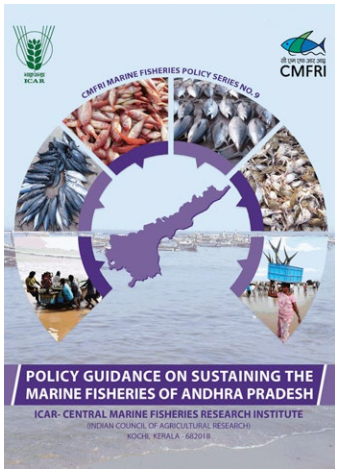
Library has a high quality digital scanner for in house scanning and digitisation of damaged old documents. Old dissertations and books were scanned,digitised and added to Repositories during the period.

Plagiarism Checking

Library made arrangements for checking plagiarism for scientific articles of the institute staff for publishing in various journals.

Library and Documentation Centre





Institute Publications

Library is entrusted with arrangements for printing, stock maintenance, distribution and sale of Institute publications. Printing arrangements made for 31 Institute publications during the period and ISBN,ISSN and Series Nos were allotted. The digital versions of Institute publications were uploaded in the Institute website.

Indian Journal of Fisheries

During the year, 4 issues of IJF Vol. 65 were published and taken to stock. Worldwide usage statistics of IJF for the year shows a total of 35972 users and 23314 users were from India. Indian Journal of Fisheries got NAAS rating 6.28.

Exchange of Publications

Library maintains exchange relationship with various National and International Research Institutes, Universities and other organisations. Mailing lists are maintained for free distribution of Institute publications.

Binding of back volumes

265 back volumes of print journals were bound during the period and added to Bound Volumes stock.

User Orientation Service

Orientation classes provided to new users and visitors from various research institutions, universities and colleges for better utilisation of library services.

Visitors

1,850 visitors comprising students and researchers from various research organisations, universities and colleges availed the library services.

CMFRI Publications released during 2018-19

- CMFRI Annual Report 2017-2018
- Cadalmin–CMFRI Newsletter No.155, 156,157 (English)
- Cadalmin–CMFRI Newsletter No. 154 (Hindi)
- Marine Fisheries Information Service No.233, 234
- Marine Fish Landings in India 2017
- Matsyagandha 2018 (Hindi)
- Indian Journal of Fisheries Vol. 65 (1-4)
- Marine Fisheries Policy Series (4): Indian Marine Fisheries Code: Guidance on a Marine Fisheries Management Model for India.
- Marine Fisheries Policy Series (9): Policy Guidance on Sustaining the Marine Fisheries of Andhra Pradesh
- CMFRI Special Publication No. 129 CATALOGUE-2018 Marine Biodiversity Museum
- CMFRI Special Publication No. 130 Enigmatic Indian Oil Sardine: An Insight
- CMFRI Special Publication No. 131 In vitro Pearl Culture Techniques: A Biotechnological Approach
- CMFRI Special Publication No. 132 Field identification of batoids – a guide to Indian species

Budget

Expenditure statement up to 31.03.2019 (Rs. In lakhs)

Sl. No.	Name of the Head	RE 2018-19	Progressive Expenditure up to 31.03.2019	Balance
	Grants for creation of Capital Assets (Capital)			
1	Works			
	(A) Land	94.53	94.53	100.00
	(B) Building			
	i Office Building	170.46	170.46	100.00
	ii Residential Building	0.00	0.00	0.00
	iii Minor Works	3.98	3.98	100.00
2	Equipments	59.17	59.17	100.00
3	Information Technology	30.14	30.14	100.00
4	Library Books and Journals	21.21	21.21	100.00
5	Vehicle & Vessels	0.00	0.00	0.00
6	Livestock	0.00	0.00	0.00
7	Furniture & Fixtures	18.76	18.76	100.00
8	Others	0.00	0.00	0.00
	Total Capital (Grants for creation of Capital Assets)	**398.25**	**398.25**	**100.00**
	Grant -in- Aid - Salaries			
1	Establishment Expenses			
	(A) Salaries			
	I Establishment charges	7147.00	7147.00	100.00
	ii Wages			
2	iii Over time Allowances			
	Grants In Aid - General (Revenue)			
1	Pension & Other Retirement Benefits	6500.00	6500.00	100.00
2	Travelling Allowance			
	(A) Domestic TA/Transfer TA	214.14	214.14	100.00
	(B) Foreign TA	1.00	1.00	100.00
3	Research & Operational Expenses			
	(A) Research Expenses	172.37	172.37	100.00
	(B) Operational Expenses	136.23	136.23	100.00
	Sub-Total	**308.60**	**308.60**	**100.00**
4	Administrative Expenses			
	(A) Infrastructure	567.88	567.88	100.00
	(B) Communication	53.37	53.37	100.00
	(C) Repairs & Maintenance			
	i Equipments, Vehicles & Others	138.57	138.57	100.00

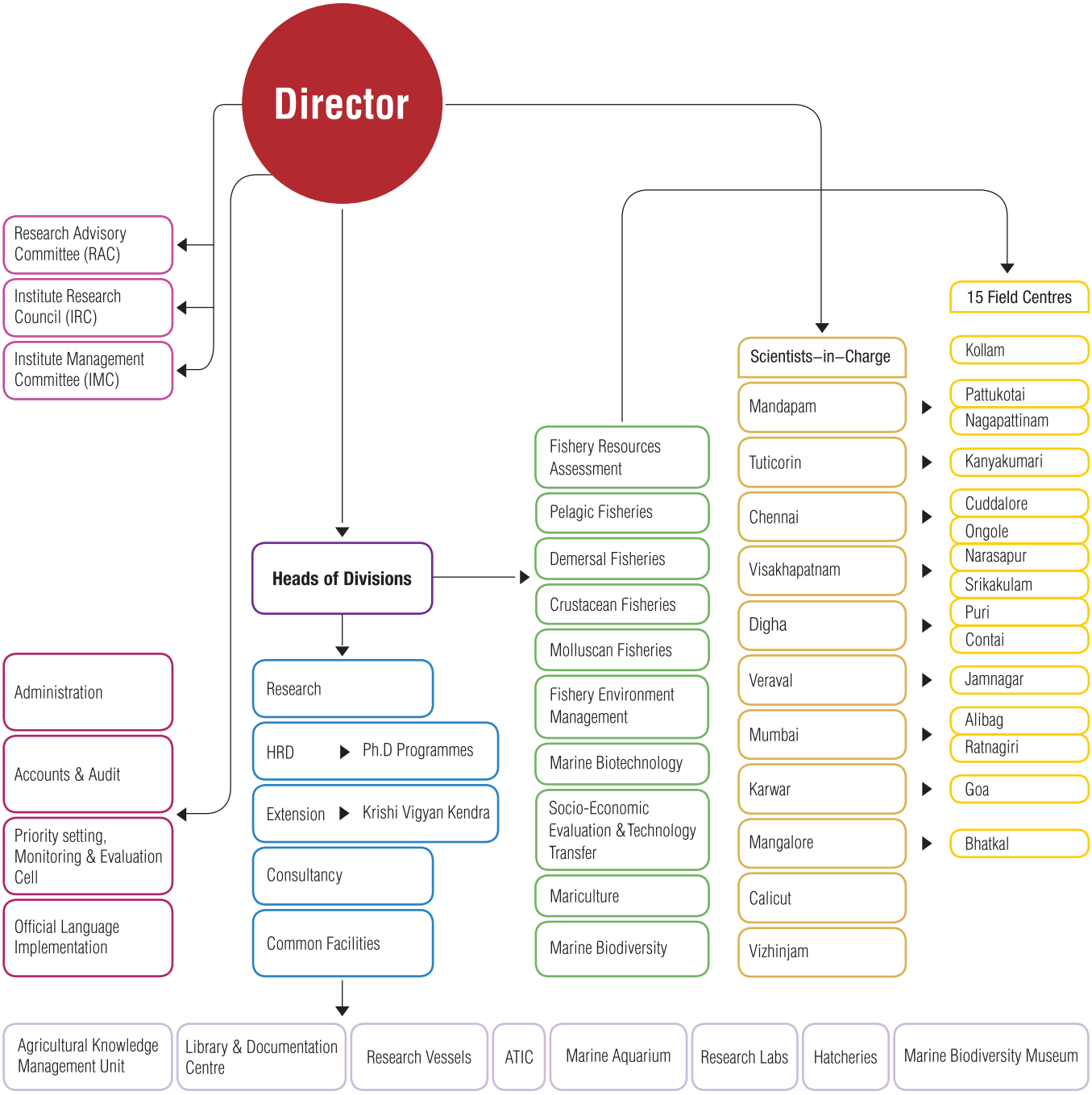
Budget

	ii Office Building	67.89	67.89	100.00
	iii Residential Building	11.36	11.36	100.00
	iv Minor Works	10.23	10.23	100.00
	(D) Others (excluding TA)	260.43	260.43	100.00
	Sub-Total	**1109.73**	**1109.73**	**100.00**
5	Miscellaneous Expenses			
	A HRD	16.00	16.00	100.00
	B Other items (Fellowships, Scholorship etc.)	6.27	6.27	100.00
	C Publicity & Exhibition	10.08	10.08	100.00
	D Guest House - Maintenance	9.34	9.34	100.00
	E Other Miscellaneous	6.62	6.62	100.00
	Sub-Total	**48.31**	**48.31**	**100.00**
	GIA General (Other than Pension) 1581.78+100.00	1681.78	1681.78	100.00
	Total GIA General	15328.78	15328.78	100.00
	Grand Total	15727.03	15727.03	100.00
	Tribal Sub Plan - Capital Expenditure	9.00	9.00	100.00
	TSP - General	20.00	20.00	100.00
	SCSP-Capital	41.75	41.75	100.00
	SCSP-General	138.22	138.22	100.00
	RE-Total	15936.00	15936.00	100.00
	Loans & Advances	30.00	30.00	100.00

Revenue 2018-19	Target	Achieved
Income from Sales/services	48.26	37.94
Fee/Subscription	31.67	24.10
Income from Royalty, publication etc.	13.10	5.21
Other Income		77.62
STD Interest		76.33
Sale of Asset		2.21
Recoveries on Loans & Advances		17.26
CPWD/Grants Refund		4.87
TOTAL	**93.03**	**245.54**

	Receipts1 (Including Opening Balance)	Expenditure	Refund	Closing Balance
Winter/Summer School	14.82	11.90	1.58	1.33
Emeritus	9.59	7.12	0.00	2.48
AINP M	305.00	304.99	0.01	0.00
NICRA	132.80	132.43	0.00	0.37
National Fund Schemes	1.46	0.00	0.00	1.46
Other Schemes	74.64	55.18	5.39	14.07
Deposit Schemes (Externally funded)	1976.47	775.48	6.36	1194.64
KVK, Narakkal	152.50	145.51	0.00	6.99
KVK, Lakshadweep	23.82	19.61	0.00	4.21
Consultancies	718.17	60.48	0.00	657.69

Organogram


Director
Research Advisory Committee (RAC)
Institute Research Council (IRC)
Institute Management Committee (IMC)
Administration
Accounts & Audit
Priority setting, Monitoring & Evaluation Cell
Official Language Implementation
Heads of Divisions
Research
HRD
Ph.D Programmes
Extension
Krishi Vigyan Kendra
Consultancy
Common Facilities
Fishery Resources Assessment
Pelagic Fisheries
Demersal Fisheries
Crustacean Fisheries
Molluscan Fisheries
Fishery Environment Management
Marine Biotechnology
Socio-Economic Evaluation & Technology Transfer
Mariculture
Marine Biodiversity
Scientists–in–Charge
Mandapam
Tuticorin
Chennai
Visakhapatnam
Digha
Veraval
Mumbai
Karwar
Mangalore
Calicut
Vizhinjam
15 Field Centres
Kollam
Pattukotai
Nagapattinam
Kanyakumari
Cuddalore
Ongole
Narasapur
Srikakulam
Puri
Contai
Jamnagar
Alibag
Ratnagiri
Goa
Bhatkal
Agricultural Knowledge Management Unit
Library & Documentation Centre
Research Vessels
ATIC
Marine Aquarium
Research Labs
Hatcheries
Marine Biodiversity Museum

Personnel

SCIENTIFIC

No	Name of Employee	Designation
CMFRI, KOCHI		
1	Dr. A. Gopalakrishnan	Director & Principal Scientist
2	Dr. K. Sunilkumar Mohammed	Principal Scientist & Head I/c
3	Dr. (Smt.) V. Kripa	Principal Scientist & Head I/c
4	Dr. P.U. Zachariah	Principal Scientist & Head I/c
5	Dr. G. Maheswarudu	Principal Scientist & Head I/c
6	Dr. T.V. Sathianandan	Principal Scientist & Head, FRAD
7	Dr. K.K. Joshi	Principal Scientist & Head, MBD
8	Dr. P. Vijayagopal	Principal Scientist & Head I/c MBTD
9	Dr. (Smt.) Imelda Joseph	Principal Scientist & Head I/c MD
10	Dr. Boby Ignatius	Principal Scientist & SIC, PME
11	Dr. J. Jayasankar	Principal Scientist/SIC, AKMU
12	Dr. (Smt.) Josileen Jose	Principal Scientist
13	Dr. K. Madhu	Principal Scientist
14	Dr. (Smt.) K.S. Sobhana	Principal Scientist
15	Dr. (Smt.) Shoji Joseph	Principal Scientist
16	Dr. E.M. Abdusamad	Principal Scientist
17	Dr. (Smt.) Rema Madhu	Principal Scientist
18	Dr. (Smt.) D. Prema	Principal Scientist
19	Dr. C. Ramachandran	Principal Scientist
20	Dr. (Smt.) Molly Varghese	Principal Scientist
21	Dr. (Smt.) Somy Kuriakose	Principal Scientist
22	Dr. V.P. Vipin Kumar	Principal Scientist
23	Dr. Shyam S. Salim	Principal Scientist
24	Dr. (Smt.) U. Ganga	Principal Scientist
25	Dr. (Smt.) Rekha J. Nair	Principal Scientist
26	Dr. (Smt.) S.Lakshmi Pillai	Principal Scientist
27	Dr. S.R. Krupesa Sharma	Principal Scientist
28	Dr.P Jayasankar	Principal Scientist
29	Dr. (Smt.) Mini. K.G.	Principal Scientist
30	Dr. P. Kaladharan	Principal Scientist
31	Dr. (Mrs.) Reeta Jayasankar	Principal Scientist
32	Dr. T.M. Najmudeen	Principal Scientist
33	Shri N.K. Sanil	Senior Scientist
34	Dr. (Smt.) N. Aswathy	Senior Scientist
35	Dr. R. Jeyabaskaran	Senior Scientist
36	Dr. Grinson George	Senior Scientist
37	Dr. Kajal Chakraborty	Senior Scientist
38	Dr. V. Venkatesan	Senior Scientist
39	Dr. (Smt.) Rekhadevi Chakraborty	Senior Scientist
40	Dr.Sandhya Sukumaran	Senior Scientist
41	Dr. Shinoj P	Senior Scientist
42	Dr. (Smt.)Miriam Paul Sreeram	Senior Scientist
43	Shri Wilson T. Mathew	Scientist
44	Dr. Pradeep M.A	Scientist
45	Ms. Reshma K.J	Scientist
46	Dr. (Smt.) Vidya R	Scientist
47	Shri Sanal Ebenezeer	Scientist
48	Shri Vivekanand Bharti	Scientist
49	Shri Rajesh N	Scientist
50	Dr.Sumithra T.G	Scientist
51	Dr. Shelton Padua	Scientist
52	Dr.Livi Wilson	Scientist
53	Dr. Jeena N.S	Scientist
54	Shri K. Mohammed Koya	Scientist
55	Dr.Sreenath K.R.	Scientist
56	Dr. Eldho Varghese	Scientist
57	Dr.(Smt).Reshma Gills	Scientist
58	Dr. Ratheesh Kumar R	Scientist
MANDAPAM REGIONAL CENTRE		
59	Dr. Rengarajan Jayakumar	Principal Scientist & SIC
60	Dr. G. Tamilmani	Senior Scientist
61	Dr.M. Sakthivel	Senior Scientist
62	Shri S. Thirumalaiselvan	Scientist
63	Shri Vinothkumar R.	Scientist
64	Shri Sankar M	Scientist
65	Shri Johnson B.	Scientist
66	Dr. P. Rameshkumar	Scientist
67	Shri Saravanan R.	Scientist
68	Dr. Anikuttan K.K	Scientist
69	Shri S. Chandrasekar	Scientist
70	Ms. Remya.L	Scientist
71	Shri Rajkumar.M.	Scientist
VISAKHAPATNAM REGIONAL CENTRE		
72	Dr. Shubhadeep Ghosh	Principal Scientist & SIC
73	Dr. S.Sathyanarayana Raju	Principal Scientist
74	Dr.Ritesh Ranjan	Senior Scientist
75	Dr. Indira Divipala	Scientist
76	Dr. Biji Xavier	Scientist
77	Dr. Muktha M.	Scientist
78	Dr. Loveson Edward L.	Scientist
79	Shri Pralaya Ranjan Behera	Scientist
80	Dr. Sekar Megarajan	Scientist

Personnel

No	Name of Employee	Designation
81	Dr. Jasmin F	Scientist
82	Dr.Manas.H.M	Scientist
PURI FIELD CENTRE		
83	Dr. Subal Kumar Roul	Scientist &SIC
84	Shri Rajesh Kumar Pradhan	Scientist
VERAVAL REGIONAL CENTRE		
85	Dr. Divu Damodaran	Scientist & SIC
86	Shri Abdul Azeez P	Scientist
87	Shri Tarachand Kumawat	Scientist
88	Shri Sukhdhane Kapil Sukhadeo	Scientist
89	Shri Vinaya Kumar Vase	Scientist
90	Shri Rajan Kumar	Scientist
91	Smt.Shikha Rahandgale	Scientist
MADRAS RESEARCH CENTRE		
92	Dr. P. Laxmilatha	Principal Scientist & SIC
93	Dr. M. Sivadas	Principal Scientist
94	Dr. (Smt.) P.T. Sarada	Principal Scientist
95	Dr. Joe K. Kizhakudan	Principal Scientist
96	Dr. (Smt.) Sobha Joe Kizhakudan	Principal Scientist
97	Dr. R. Narayanakumar	Principal Scientist & Head I/c, SEETTD
98	Dr. (Ms.) A. Margaret Muthu Rathinam	Principal Scientist
99	Dr.A.K. Abdul Nazar	Principal Scientist
100	Dr. Vidya Jayasankar	Principal Scientist
101	Dr. Srinivasa Raghavan V	Scientist
102	Shri Adnan Hussain gora	Scientist
103	Ms. Saima Rehman	Scientist
104	Ms. E.M. Chhandaprajnadarsini	Scientist
MUMBAI RESEARCH CENTRE		
105	Dr. Anulekshmi Chellappan	Scientist & SIC
106	Shri Bhendekar Santosh Nagnath	Scientist
107	Dr.S.Ramkumar	Scientist
108	Dr. Akhilesh K.V	Scientist
109	Shri Nakhawa Ajay Dayaram	Scientist
MANGALORE RESEARCH CENTRE		
110	Dr. Prathibha Rohit	Principal Scientist & SIC & Head I/c PFD
111	Dr. A.P. Dinesh Babu	Principal Scientist
112	Dr. Sujitha Thomas	Principal Scientist
113	Dr. (Smt.) Geetha Sasikumar	Principal Scientist
114	Dr. K.M. Rajesh	Principal Scientist
115	Dr. (Smt.) Bindu Sulochanan	Senior Scientist
116	Dr. Divya Viswambharan	Scientist
117	Dr. Purushottama G.B.	Scientist
TUTICORIN RESEARCH CENTRE		
118	Dr. P.P. Manoj Kumar	Principal Scientist & SIC
119	Dr. I. Jagadis	Principal Scientist
120	Dr. (Smt.) Asha. P.S.	Principal Scientist
121	Dr. (Mrs.) C.P. Suja	Principal Scientist
122	Dr. C Kalidas	Scientist
123	Dr.L.Ranjith	Scientist
124	Ms. Kavitha M	Scientist
125	Shri Linga Prabhu D	Scientist
KARWAR RESEARCH CENTRE		
126	Dr. Jayasree Loka	Principal Scientist & SIC
127	Dr. T. Senthil Murugan	Senior Scientist
128	Dr. Suresh Babu.P.P	Senior Scientist
129	Ms. Saloni Shivam	Scientist
130	Shri Kurva Raghu Ramudu	Scientist
131	Dr. Anuraj.A	Scientist
DIGHA RESEARCH CENTRE		
132	Dr. Gyanranjan Dash	Scientist
133	Dr. Swathipriyanka Sen Dash	Scientist
VIZHINJAM RESEARCH CENTRE		
134	Dr. M.K. Anil	Principal Scientist & SIC
135	Dr. (Smt.) S. Jasmine	Principal Scientist
136	Dr. (Smt.) P.S. Swathilekshmi	Principal Scientist
137	Dr. B. Santhosh	Principal Scientist
138	Dr. (Smt.) K.N. Saleela	Senior Scientist
139	Ms. Surya S	Scientist
140	Shri Ambarish P Gop	Scientist
141	Ms. P. Gomathi	Scientist
CALICUT RESEARCH CENTRE		
142	Dr. P.K. Asokan	Principal Scientist & SIC
143	Dr. Gulshad Mohamed	Principal Scientist
144	Dr. K. Vinod	Principal Scientist
145	Smt. Ramya Abhijith	Scientist
146	Dr. Mahesh V.	Scientist
147	Ms. Shilta M.T	Scientist
148	Shri K.P. Said Koya	Scientist
KVK NARAKKAL		
149	Dr. Shinoj Subramannian	Sr.Scientist & PC

TECHNICAL

HEADQUARTERS KOCHI		
1	Shri P.S. Anilkumar	ACTO
2	Smt. G. Shylaja	ACTO
3	Smt. P. Geetha	ACTO (Library)
4	Shri N. Viswanathan	Assistant Chief Technical Officer (Civil)
5	Smt. E.K. Uma	Assistant Chief Technical Officer (Hindi Translator)
6	Smt. K. Ramani	ACTO
7	Shri P.K Harikumar	ACTO
8	Shri N.K. Harshan	Senior Technical Assistant
9	Shri P.S. Alloycious	Senior Technical Assistant
10	Shri K.C. Hezhakiel	Senior Technical Assistant
11	Smt. Jenni. B	Senior Technical Officer

Personnel

No	Name of Employee	Designation
12	Shri Sijo Paul	Senior Technical Officer
13	Smt. K.P. Salini	Senior Technical Officer
14	Shri K.M. Venugopalan	Senior Technical Officer
15	Smt. P.K. Seetha	Senior Technical Officer
16	Dr. M.P. Paulton	Senior Technical Officer (Training)
17	Smt. P.M. Geetha	Technical Officer (Museum)
18	Shri K.N. Pushkaran	Technical Officer
19	Shri V.K. Manu	Technical Officer(Programm Assistant-Computer)
20	Shri P.K. Baby	Technical Officer
21	Shri K.G. Baby	Technical Officer
22	Smt. Sindhu K. Augustine	Technical Officer
23	Shri A. Padmanabha	Technical Officer (Electrical)
24	Shri K.G. Radhakrishnan Nair	Technical officer (Motor Driver)
25	Smt.. Dipti N.V	Technical Officer (Programme Assistant - Laboratory Technician)
26	Shri Arun Surendran P.S	Senior Technical Assistant
27	Smt.. Lavanya Ratheesh	Senior Technical Assistant
28	Shri K. Solaman	Senior Technical Assistant
29	Shri Manjeesh .R	Technical Assistant (Computer Application)
30	Shri M.N. Sathyan	Technial Assistant (Motor Driver)
31	Smt.Sajeela.K.A	Technical Assistant
32	Shri Sajikumar K.K	Technical Assistant
33	Shri Retheesh T.B.	Technical Assistant
34	Smt. Anusree V.Nair	Technical Assistant
35	Shri Binoy Bhaskaran	Technical Assistant
36	Shri Ragesh .N	Technical Assistant
37	Shri.Sayooj P	Technical Assistant
38	Shri Aju. K. Raju	Technical Assistant
39	Smt. Reena V Joseph	Technical Assistant
40	Shri K.M. David	Technical Assistant (Artist)
41	Shri C.V. Jayakumar	Technical Assistant (Press & Editorial)
42	Smt. Vandanaa.V	Technical Assistant(Hindi Translator)
43	Shri P.R. Abhilash	Technical Assistant (Exb.Asst)
44	Shri M. Radhakrishnan	Senior Technician
45	Smt. Dhanya G.	Senior Technician
46	Shri David Babu	Senior Technician
47	Shri M.P. Mohandas	Senior Technician
48	Shri V.H. Venu	Senior Technician
49	Smt. J. Sudhadevi	Senior Technician
50	Smt. Shyamala. M.P.	Senior Technician
51	Shri P.V. Sunil	Senior Technician
52	Shri Shaji. A.K.	Senior Technician
53	Smt. Sheela. P.P.	Senior Technician
54	Shri Jestin Joy. K.M.	Senior Technician
55	Shri Sreekumar. K.M.	Technician
56	Shri Vijayan. M.T.	Technician
57	Shri Kishor T.G	Technician
58	Shri Sreesanth.L	Technician
59	Shri Sunil.K.T.S	Technician
60	Shri Jishnudev M.A	Technician
61	Smt. S. Prasannakumari	Technician
62	Shri Abbas.A.Mohammed	Technician(On temporary transfer)
63	Shri Anoob P.Anassery	Technician
QUILON FIELD CENTRE		
64	Shri Paulose Jacob Peter	Technician
65	Shri Ratheesh T	Senior Technical Assistant
MANDAPAM REGIONAL CENTRE		
66	Dr.V.Mohan	ACTO (Library)
67	Shri I. Mendonza Xavier	Senior Technical Officer (Draughtsman)
68	Shri S. Sekar V. Rayer	Technical Officer (Skin Diver)
69	Shri A. Vairamani	Technical Officer
70	Shri A. Gandhi	Technical Officer
71	Shri N. Bhoominathan	Senior Technical Assistant
72	Shri G. Hanumantha Rao	Senior Technical Assistant
73	Shri M. Asokan	Senior Technical Assistant(Painter-cum-Polisher)
74	Smt. Priya K.M	Technical Assistant(Hindi Translator)
75	Shri Vijaya Karthikeyan	Technical Assistant (Electrician)
76	Shri M. Palanichamy	Senior Technician (Electrician)
77	Shri K. Shanmughanathan	Senior Technician
78	Shri M. Jayasingh	Techincian
79	Shri S. Murugaboopathy	Senior Technician
80	Shri N. Ramakrishnan	Senior Technician
81	Shri I. Syed Sadiq	Senior Technician
82	Shri V. Muniasamy	Senior Technician
83	Shri B. Kathiresan	Technician
84	Shri K. Muniyasamy	Technician
85	Shri M. Ganesan	Technician
86	Shri M. Thayalan	Technician
87	Shri K. Senthil Kumar	Technician
88	Shri Tinto Thomas	Technician
NAGAPATINAM FIELD CENTRE		
89	Shri A.Ramesh	Technician
PATTUKOTTAI FIELD CENTRE		
90	Shri A. Kumar	ACTO
91	Shri S.M. Sikkender Batcha	Senior Technician
VISAKHAPATNAM REGIONAL CENTRE		
92	Dr. Phalguni Pattnaik	Assistant Chief Technical Officer
93	Shri R.V.D. Prabhakar	Technical Officer
94	Shri T. Nageswara Rao	Technical Officer
95	Shri K. Gouri Sankara Rao	Technical Officer(Computer)
96	Shri P. Venkataramana	Technical Officer
97	Shri Ravi Kumar Avadhanula	Technical Assistant
98	Shri Narsimhulu Sadhu	Senior Technical Assistant
99	Shri Mamidi Satishkumar	Senior Technical Assistant
100	Shri Balla Vamsi	Technical Assistant
101	Shri Chinni Babu Bathina	Technical Assistant

Personnel

No	Name of Employee	Designation
102	Shri Suresh Kumar Pilli	Technical Assistant
103	Shri R.P. Venkatesh	Senior Technician (Fitter)
104	Smt. Sangaru Padmaja Rani	Senior Technician
105	Shri Durga Suresh Relangi	Senior Technician
106	Shri Rachakonda Shivaraju	Technician
107	Shri D. Bhaskara Rao	Senior Technician
108	Shri D. Jaganna	Senior Technician
109	Shri C.H. Moshe	Senior Technician
110	Shri Panchakarla Nagaraju	Technician
111	Ms.Renuka K	Technician
112	Ms Menaka Das	Technician
NARASAPUR FIELD CENTRE		
113	Shri S. Tatabhai	Technical Assistant
PURI FIELD CENTRE		
114	ShriM. Kala Mallik	Technician
115	Dr. Biswajit Dash	Assistant Chief Technical Officer
116	Dr. Madhumita Das	Assistant Chief Technical Officer
117	Shri Prakash Chandra Das	Technician
SRIKAKULAM FIELD CENTRE		
118	Shri Y.V.S. Suryanarayana	Senior Technical Assistant
119	Shri Ashok Maharshi	Senior Technical Assistant
VERAVAL REGIONAL CENTRE		
120	Shri Suresh Kumar Mojjada	ACTO
121	Shri Fofandi Mahendra Kumar	ACTO
122	Shri Polara Jamnadas Premji	Technical Officer
123	Shri Ladani Amrutlal Arjunbhai	Technical Officer
124	Shri Vanvi Jayaanthilal Dayabhai	Technical Officer
125	Shri Chudasama Ramji Raja	Senior Technical Assistant
126	Shri H.M. Bhint	Technical Assistant
127	Shri Solanki Vipulkumar Mulajibhai	Technician
128	Ms. Gohel Jayshree Khimji	Technician
129	Shri Chudasama Karsan Punja	Technician
130	Shri Bhatt Bhargav Hareshbhai	Technician
JAMNAGAR FIELD CENTRE		
131	Shri Makadia B.V.	Technical Officer
132	Shri Makwana Somapitha	Senior Technician
MADRAS RESEARCH CENTRE		
133	Shri S. Mohan	Assistant Chief Technical Officer
134	Shri D. Pugazhendi	Assistant Chief Technical Officer
135	Shri K.Diwakar	Assistant Chief Technical Officer
136	Shri P. Jaiganesh	Technical Officer
137	Smt. S. Gomathy	Senior Technical Officer
138	Shri N. Rudhramurthy	Senior Technical Officer
139	Shri K.S. Shiak Mohamed Yousuf	Senior Technical Assistant
140	Shri S. Selvanidhi	Senior Technical Assistant
141	Shri R. Vasu	Senior Technician
142	Shri R. Sunder	Senior Technician
143	Shri V. Joseph Xavier	Senior Technician
144	Shri Bareen Mohamed	Senior Technician
145	Shri V. Sitaramacharyulu	Technician
146	Smt.Sini.M.B	Technician
147	Shri J.Balaji	Technician
CUDDALORE FIELD CENTRE		
148	Shri S. Pradeep	Senior Technician
149	Shri Vishnu P.G	Technician
KOVALAM FIELD LAB		
150	Shri R. Ponniah	Technical Officer(Electrical)
151	Shri.M.Anbarasu	Sr.Technical Assistant
152	Smt. I. Santhosi	Senior Technician
ONGOLE FIELD CENTRE		
153	Shri S.V. Subba Rao	Senior Technical Assistant
154	Shri G. Sudhakar	Technical Officer
MUMBAI RESEARCH CENTRE		
155	Shri Nilesh Anil Pawar	ACTO
156	Shri Thakurdas	Technical Officer
157	Shri Jayadev S. Hotagi	Technical Officer
158	Shri B.B. Chavan	Technical Officer
159	Shri Baban N. Katkar	Technical Officer
160	Shri Bashir Ahmed Adam Shilodar	Technical Officer
161	Shri Suresh Krishnaro Kamble	Senior Technical Assistant
162	Shri Sashikant R. Yadav	Senior Technical Assistant (Motor Driver)
163	Shri Punam Ashok Khandagle	Senior Technical Assistant
164	Shri Vaibhav Dinkar Mhatre	Senior Technical Assistant
165	Shri Umesh Hari Rane	Technical Assistant
166	Shri M.P. Jadhav	Senior Technician
167	Shri Bhangare Sunil Ramachandra	Technician
ALIBAG FIELD CENTRE		
168	Shri Sonara Yogesh Zinabhai	Technician
169	Shri Shrikrishna Pandurang Hotekar	Technician
RATNAGIRI FIELD CENTRE		
170	Shri D.D. Sawant	Technical Officer
171	Shri.Prabhakar Sankar Salvi	Senior Technician
172	Shri Digambar Suresh Kumbhar	Technician
173	Shri Mahendra Pandit Sonawane	Technician
MANGALORE RESEARCH CENTRE		
174	Shri V. Lingappa	Technical Officer
175	Dr. Veena Shettigar	Technical Officer
176	Shri U. Jeyaram	Technical Officer
177	Shri C.G. Ulvekar	Senior Technical Assistant
178	Shri M. Chaniappa	Technical Officer
179	Shri G.D. Nataraja	Technical Officer
180	Shri P. Harshakumar	Senior Technical Assistant (Motor Driver)
181	Shri Karamathullah Sahib. P	Senior Technician

Personnel

No	Name of Employee	Designation
BHATKAL FIELD CENTRE		
182	Shri Udaya V. Arghekar	Technical Officer
183	Shri Ganesh Bhatkal	Technical Officer
TUTICORIN RESEARCH CENTRE		
184	Shri S. Mohamed Sathakathullah	Technical Officer
185	Shri N. Jesuraj	Technical Officer (Skin Diver)
186	Shri P. Muthukrishnan	Technical Officer (Skin Diver)
187	Shri J. Padmanathan	Senior Technical Assistant
188	Shri K.P. Kanthan	Technical Assistant
189	Shri K. Ramaswamy	Technical Assistant(Motor Driver)
190	Smt. B. Koncies Mary	Senior Technician
191	Shri K. Murugan	Senior Technician
192	Shri S. Willington	Technician
193	Ms.Sruthi.N.S	Technician
194	Shri N. Ramaswamy	Technician
KANYAKUMARI FIELD CENTRE		
195	Shri P. Rajendran	Sr. Technician
KARWAR RESEARCH CENTRE		
196	Shri Narayan G. Vaidya	Senior Technical Officer
197	Shri S. Satyanarayan V. Pai	Technical Officer
198	Ms. Sonali S. Mhaddolkar	Senior Technical Assistant
199	Shri Kodi Srinivasa Rao	Senior Technical Assistant
200	Dr. Praveen Narayan Dube	Technical Assistant
201	Shri N. Selvakumar	Senior Technician
202	Smt. Pramila Harish Borkar	Senior Technician
DIGHA RESEARCH CENTRE		
203	Shri Swapan Kumar Kar	Technical Officer
204	Shri Indranil Mukherjee	Technician
VIZHINJAM RESEARCH CENTRE		
205	Shri V.A.Leslie	Senior Technical Officer
206	Shri K.K. Suresh	Senior Technical Officer
207	Shri Jose Kingsly	Senior Technical Officer
208	Shri A. Udayakumar	Senior Technical Officer
209	Shri V.P. Benziger	Technical Officer (Deckhand)
210	Shri B. Raju	Senior Technical Assistant
211	Shri Albert Idu K.A	Technical Assistant
CALICUT RESEARCH CENTRE		
212	Shri V.A. Kunhikoya	Senior Technical Officer
213	Shri N.P. Ramachandran	Senior Technical Assistant
214	Shri C. Chandran	Senior Technical Assistant
215	Smt. P. Renuka	Senior Technician
216	Shri Ansar Pokkarakath	Technician
217	Ms. Silpa P.G	Technician
218	Shri T. Rajesh Babu	Technician

No	Name of Employee	Designation
KANNUR DATA COLLECTING POINT		
219	Shri Shiju P.	Sr.Technician
KVK NARAKKAL		
220	Smt. P. Sreelatha	Chief Technical Officer
221	Shri F. Pushparaj Anjelo	ACTO (SMS- Agricultural Extension)
222	Dr. Karikkathil Smitha Sivadasan	ACTO (SMS- Animal Husbandry)
223	Shri Shoji Joy Edison	ACTO (SMS- Horticulture)
224	Dr. Vikas P.A	ACTO (SMS- Fisheries)
225	Shri Sineesh Ambi	Technician (Motor Driver)
226	Shri Binoop C.S	Technician (Motor Driver)
KVK LAKSHADWEEP		
227	Dr.Abdul Gafoor.V.M	Senior Technical Officer (SMS-Poultry& Animal Science)
228	Shri A. Anasukoya	Technical Officer

ADMINISTRATIVE

HEADQUARTERS KOCHI		
1	Shri C. Muralidharan	Chief Administrative oficer
2	Shri A.V. Joseph	Comptroller
3	Smt.N.K.Anupama	Assistant Finance&Accounts Officer
4	Smt.Sreedevi.M.R	Assistant Finance&Accounts Officer
5	Smt. Meera. K.N.	Assistant Administrative Officer
6	Shri P.V. Devassy	Assistant Administrative Officer
7	Smt. C.M. Jenny	Assistant Administrative Officer
8	Smt. V.K. Sobha	Assistant Administrative Officer
9	Smt. Ponnamma Radhakrishnan	Assistant Administrative Officer
10	Shri K. Ramadasan	Assistant Administrative Officer
11	Smt. Febeena P.A.	Junior Accounts Officer
12	Smt. N.G. Supriya	Assistant
13	Smt. M. Safiyabi	Assistant
14	Shri Rishikesh Aandi	Assistant
15	Smt. Molly Lazer	Assistant
16	Smt. G. Ambika	Assistant
17	Smt. V. Jayalakshmi	Assistant
18	Smt. C.A. Leela	Assistant
19	Smt. Manjusha G. Menon	Assistant
20	Ms. Soumya Surendran	Assistant
21	Ms. Ramya M	Assistant
22	Shri C.K. Sivadas	Assistant
23	Smt. P.K. Mary	Assistant
24	Smt. Binny Cherian	Assistant
25	Smt. Gouri Hareendran	Assistant
26	Smt. T.C. Chandrika	Assistant
27	Shri K.S. Ajith	Assistant
28	Shri Roshin Pushpan	Assistant
29	Smt.Sumeena N.K	Assistant
30	Smt. C. Devaki	Assistant

Personnel

No	Name of Employee	Designation
31	Shri Sunil A.T	Assistant
32	Shri Joseph Mathew	Assistant
33	Shri D. Augustus Julin Raj	Assistant
34	Smt. N.R. Lethadevi	Private Secretary
35	Smt. P. Vineetha	Private Secretary
36	Shri C.D. Manoharan	Private Secretary
37	Shri K.N. Muraly	Personal Assistant
38	Smt. P.K. Anitha	Private Secretary
39	Smt. Bindu Sanjeev	Personal Assistant
40	Smt. K. Smitha	Personal Assistant
41	Smt Annies Mary Paulose	Upper Division Clerk
42	Shri T.K. Sumesh	Upper Division Clerk
43	Shri K.S. Sunil Raj	Upper Division Clerk
44	Smt. Deepa P.N.	Upper Division Clerk
45	Smt. Manju Jose	Upper Division Clerk
46	Shri R. Balakrishnan	Upper Division Clerk
47	Shri E.A. Roopesh	Upper Division Clerk
48	Smt. Sujatha K.K	Upper Division Clerk
49	Smt. Saritha L.	Stenographer Grade III
50	Smt. Dhanya M.B	Stenographer Grade III
51	Smt. Zulekha	Stenographer Grade III
52	Smt. Sreeja N.P	Lower Division Clerk
53	Ms. Sandhya C.K.	Lower Division Clerk
54	Shri S. Sreekumar	Upper Division Clerk
55	Shri.Rajesh.T.K	Lower Division Clerk
MANDAPAM REGIONAL CENTRE		
56	Shri C. Jayakanthan	Assistant Administrative Officer
57	Smt. M. Rameswari	Assistant
58	Shri. B James	Upper Division Clerk
59	Shri M. Shahul Hameed	Upper Division Clerk
60	Shri B.Palanivelmurugan	Upper Division Clerk
61	Shri M. Saravanan	Lower Division Clerk
62	Smt. M. Valarmathi	Lower Division Clerk
63	Shri R. Saravanan	Lower Division Clerk
VISAKHAPATNAM REGIONAL CENTRE		
64	Smt. D. Madhavi Latha	Assistant
65	Smt. G. Hemlata	Assistant Finance & Accounts Officer
66	Smt. N.C. Saroja	Assistant
67	Shri L. Pydi Raju	Upper Division Clerk
VERAVAL REGIONAL CENTRE		
68	Shri Chandra Mauli Sharma	Assistant Administrative Officer
69	Shri Vanvi Mansukhlal Madhavji	Assistant
70	Shri Rohit A. Chowda	Lower Division Clerk
71	Shri Pandya Jatin Kumar	Lower Division Clerk
MADRAS RESEARCH CENTRE		
72	Shri Ashish Chobey	Assistant Administrative Officer
73	Shri W. Sathyavan Neelraj	Upper Division Clerk
74	Shri A. Yesudhas	Upper Division Clerk
75	Shri S. Yuvarajan	Assistant
76	Shri S.Maharajan	Lower Division Clerk
77	Smt. S. Anjalidevi	Lower Division Clerk
MUMBAI RESEARCH CENTRE		
78	Smt. Ashlesha Ashok Sawant	Assistant
79	Ms. Priyankakumari	Assistant
80	Shri Vinod P. Bhagayatkar	Assistant
MANGALORE RESEARCH CENTRE		
81	Shri Upendar Kumar	Assistant
82	Shri U. Purandhara Shetty	Assistant
TUTICORIN RESEARCH CENTRE		
83	Smt. T. Mahalakshmi	Assistant
84	Shri A. Dickson Jebaraj	Assistant
85	Shri J. Vinoth Prabhu Vaz	Assistant
86	Shri K. Jerald Raja	Assistant
87	Smt. R. Anantharani	Lower Division Clerk
KARWAR RESEARCH CENTRE		
88	Shri Ratan P. Naik	Lower Division Clerk
DIGHA RESEARCH CENTRE		
89	Shri Santosh Kumar	Assistant
VIZHINJAM RESEARCH CENTRE		
90	Smt. Radhika Krishnan	Assistant
91	Smt. K. Latha	Assistant
92	Smt. M.P. Kaladevi	Upper Division Clerk
CALICUT RESEARCH CENTRE		
93	Shri R. Sreenivasan	Assistant Administrative Officer
94	Smt. K.P. Shylaja	Assistant
95	Smt. K. Balamani	Assistant
96	Shri C.P. Umasankar	Upper Division Clerk
KVK NARAKKAL		
97	Smt. Rincy K.R.	Stenographer Grade III

SKILLED

HEADQUARTERS KOCHI		
1	Shri K.C. Rajappan	Skilled Support Staff
2	Shri K.G. Jayaprasad	Skilled Support Staff
3	Shri T.K. Antony	Skilled Support Staff
4	Smt. K.T. Prakasini	Skilled Support Staff
5	Smt. P.K. Usha	Skilled Support Staff
6	Shri M.D. Suresh	Skilled Support Staff
7	Smt. Usha. S.	Skilled Support Staff
8	Smt. P.K. Sujatha	Skilled Support Staff
9	Shri M.J. Joseph	Skilled Support Staff
10	Smt. Subaida. K.S.	Skilled Support Staff
11	Smt. K.S. Jeeji	Skilled Support Staff

Personnel

No	Name of Employee	Designation
12	Shri Biju George	Skilled Support Staff
13	Shri P.M. Gireesh	Skilled Support Staff
14	Smt. T.R. Kumari	Skilled Support Staff
15	Shri M.K.Anil Kumar	Skilled Support Staff
16	Shri Rajesh P.A	Skilled Support Staff
17	Smt. Unniresmi C.U	Skilled Support Staff
18	Shri Akhil Babu V	Skilled Support Staff
19	Smt. Rinku Joseph	Skilled Support Staff
20	Smt. Deepa.R	Skilled Support Staff
21	Smt. Vijayalakshmi V.V	Skilled Support Staff
22	Shri Kaushik T.R	Skilled Support Staff
23	Shri Prashanth P.K	Skilled Support Staff
24	Shri Sibin P. Babu	Skilled Support Staff
25	Shri Ratheesh M	Skilled Support Staff
26	Ms. Sethulakshmi M	Skilled Support Staff
27	Shri Joby P.J	Skilled Support Staff
28	Shri Vishnu B	Skilled Support Staff
29	Smt. Anaswara.K.B	Skilled Support Staff
30	Shri Pakkri Muthu S	Skilled Support Staff
31	Smt. Sruthy S	Skilled Support Staff
32	Smt. Jesli Disilva	Skilled Support Staff
33	Shri Akhildev S	Skilled Support Staff
34	Smt. Sreelakshmi S	Skilled Support Staff
35	Smt. Binitha Babu	Skilled Support Staff
36	Smt. Remya E.A	Skilled Support Staff
37	Shri Ullas Shankar	Skilled Support Staff
38	Smt. Jinimol.K.P	Skilled Support Staff
39	Smt. Hima P.H	Skilled Support Staff
40	Smt. Divya K.A	Skilled Support Staff
41	Smt. Aswathy A.S	Skilled Support Staff
42	Shri Eldhose Benny	Skilled Support Staff
43	Shri Thobias P. Antony	Skilled Support Staff
44	Shri Vysakhan P	Skilled Support Staff
45	Shri Sujith R	Skilled Support Staff
46	Smt. Marjana.P.M	Skilled Support Staff
47	Smt. Reshma.K.S	Skilled Support Staff
48	Shri Abilash Velayudhan	Skilled Support Staff
49	Smt. Keerthy Krishna	Skilled Support Staff
50	Ms. Athira T.G	Skilled Support Staff
51	Smt. Preethy Udayabhanu	Skilled Support Staff
52	Shri Vipinkumar K.K	Skilled Support Staff
53	Shri Jerin V. Jose	Skilled Support Staff
54	Shri Augustine Sipson N.A.	Skilled Support Staff
55	Shri Akhil A.R	Skilled Support Staff
56	Shri Seban John	Skilled Support Staff
57	Smt. Emy K Baby	Skilled Support Staff
58	Smt. Nandana.P.R	Skilled Support Staff
MANDAPAM REGIONAL CENTRE		
59	Shri K. Thangavelu	Skilled Support Staff
60	Shri U. Rajendran	Skilled Support Staff
61	Shri K. Jeevanandam	Skilled Support Staff
62	Shri N. Nagamuthu	Skilled Support Staff
63	Smt. Subbulakshmi	Skilled Support Staff
64	Shri M. Saravana Kumar	Skilled Support Staff
65	Shri K. Ganesan	Skilled Support Staff
66	Shri N. Ramamoorthy	Skilled Support Staff
67	Smt. M. Saraswathi	Skilled Support Staff
68	Shri N. Thirupathi	Skilled Support Staff
69	Shri A. Bose	Skilled Support Staff
70	Shri K. Narayanan	Skilled Support Staff
71	Smt. M. Muthuvelu	Skilled Support Staff
72	Shri T. Jothi Manikandan	Skilled Support Staff
73	Smt. S. Sabiya Begum	Skilled Support Staff
74	Shri Suresh R	Skilled Support Staff
75	Shri A. Mohammed Kaleem	Skilled Support Staff
76	Smt. M. Afrin Rani	Skilled Support Staff
77	Shri J. Ramachandran	Skilled Support Staff
78	Shri M. Mahalingam	Skilled Support Staff
79	Smt. K. Mathavi	Skilled Support Staff
80	Shri Ravikumar T.T	Skilled Support Staff
81	Shri B. Sravanakumar	Skilled Support Staff
82	Shri R. Rajkumar	Skilled Support Staff
83	Shri Aneesh U	Skilled Support Staff
84	Shri S. Joseph Jegan	Skilled Support Staff
85	Shri V. Anand	Skilled Support Staff
86	Shri V. Jayapradeep	Skilled Support Staff
87	Ms.Divya Bharathy S	Skilled Support Staff
VISAKHAPATNAM REGIONAL CENTRE		
88	Shri D. Lingaraju	Skilled Support Staff
89	Shri Oggu China Venkateswarlu	Skilled Support Staff
90	Shri S. Srinivasulu	Skilled Support Staff
91	Shri R. Pydi Raju	Skilled Support Staff
92	Shri P. Venkatesh	Skilled Support Staff
93	Shri Damodara Rao Padumu	Skilled Support Staff
94	Shri Siram Nookaraju	Skilled Support Staff
95	Shri Seera Harish	Skilled Support Staff
96	Shri Potala Bhaskara Rao	Skilled Support Staff
97	Shri Venkateswarulu Vuyyala	Skilled Support Staff
98	Shri Yenni Prasad Babu	Skilled Support Staff
99	Shri P.Shanmukh Deekshit Kumar	Skilled Support Staff
100	Shri Palli Kalidasu	Skilled Support Staff
VERAVAL REGIONAL CENTRE		
101	Shri Haridas Khimdas Makwana	Skilled Support Staff
102	Shri Ladani Dhirajlal Jamnadas	Skilled Support Staff
103	Smt. Santok A. Bharada	Skilled Support Staff
104	Shri Bhint Mitesh Hiralal	Skilled Support Staff
105	Shri Chorvadi Kamlesh Kalidas	Skilled Support Staff

Personnel

No	Name of Employee	Designation
106	Shri Thakar Milan Rajnikant	Skilled Support Staff
107	Shri Mushagra Rajit Hasam	Skilled Support Staff
108	Shri Gadhiya Noormamad Alibhai	Skilled Support Staff
MADRAS RESEARCH CENTRE		
109	Smt. R. Kalaiselvi	Skilled Support Staff
110	Shri R. Kumaran	Skilled Support Staff
111	Smt. R. Sarojini	Skilled Support Staff
112	Smt. R. Eswari	Skilled Support Staff
113	Ms. P. Prasannakumari	Skilled Support Staff
114	Shri Midhun Muthayan	Skilled Support Staff
115	Shri T. Balaraman	Skilled Support Staff
116	Shri A. Vinoth	Skilled Support Staff
117	Shri K. Prabhakaran	Skilled Support Staff
118	Shri Raja Sekar R	Skilled Support Staff
119	Shri R.Yuvaraj	Skilled Support Staff
120	Smt. Niranjana A	Skilled Support Staff
MUMBAI RESEARCH CENTRE		
121	Shri K.K. Baikar	Skilled Support Staff
122	Shri D.D. Jangam	Skilled Support Staff
123	Smt. Urmila S. Balmiki	Skilled Support Staff
124	Shri Ashish C.S. Chaturvedi	Skilled Support Staff
125	Shri Vicky Kumar Prajapati	Skilled Support Staff
126	Smt. Vijisha M	Skilled Support Staff
127	Shri Suresh	Skilled Support Staff
128	Shri Vaibhav Milan Tawde	Skilled Support Staff
129	Shri Vaibhav Jayant Gharat	Skilled Support Staff
130	Shri Asharam Choudhary	Skilled Support Staff
131	Shri M.Saravanakumar	Skilled Support Staff
MANGALORE RESEARCH CENTRE		
132	Shri S. Mahalinga Naik	Skilled Support Staff
133	Smt, Thanujakshi	Skilled Support Staff
134	Shri Shrinath B	Skilled Support Staff
135	Shri Nagaraj Somayya Gond	Skilled Support Staff
136	Smt. Sathyavathi	Skilled Support Staff
137	Ms. Pushpa K.	Skilled Support Staff
138	Shri Dharmaraju L.B	Skilled Support Staff
139	Shri Sujith Kumar	Skilled Support Staff
140	Shri Naveen Raju K.G. Naik	Skilled Support Staff
TUTICORIN RESEARCH CENTRE		
141	Shri Santhakumar A	Skilled Support Staff
142	Shri S. Alagesan	Skilled Support Staff
143	Shri I. Ravindran	Skilled Support Staff
144	Shri S. Mariappan	Skilled Support Staff
145	Shri M. Soundrapandian	Skilled Support Staff
146	Shri M. Kalimuthu	Skilled Support Staff
147	Shri K. Subramanian	Skilled Support Staff
148	Shri A. Paul Pondi	Skilled Support Staff
149	Smt. A. Usha Rani	Skilled Support Staff
150	Shri C.S. Santhanakumar	Skilled Support Staff
151	Shri K. Chandran	Skilled Support Staff
152	Shri K. Krishnan	Skilled Support Staff
153	Shri K. Anandan	Skilled Support Staff
KARWAR RESEARCH CENTRE		
154	Shri Subhash K. Naik	Skilled Support Staff
155	Shri Ramakant Shankar Harikantra	Skilled Support Staff
156	Smt. Nandini Mayekar	Skilled Support Staff
157	Shri T.P. Renilkumar	Skilled Support Staff
158	Ms. Pooja Mahabaleswar Gajinkar	Skilled Support Staff
159	Shri Vineeth T	Skilled Support Staff
160	Ms. Veena Ulhas Kamble	Skilled Support Staff
161	Shri Ravichandra Angadi	Skilled Support Staff
162	Shri. Manoj Rajendra Hulaswar	Skilled Support Staff
163	Smt.Vijayalakshmi Y G	Skilled Support Staff
164	Shi Nagaraj Mohan Durgekar	Skilled Support Staff
GOA FIELD CENTRE		
165	Shri Suraj Surendra Kalgutkar	Skilled Support Staff
VIZHINJAM RESEARCH CENTRE		
166	Shri B. Babu	Skilled Support Staff
167	Smt. T. Jayakumari	Skilled Support Staff
168	Shri S. Satheesh Kumar	Skilled Support Staff
169	Ms. Sharanya M.P	Skilled Support Staff
170	Ms. Krishna Priya P.M	Skilled Support Staff
171	Shri Jithesh P.T	Skilled Support Staff
172	Smt. Shalini O.	Skilled Support Staff
173	Smt. Nisha S	Skilled Support Staff
174	Shri Anoop K.G	Skilled Support Staff
175	Shri Greever Yoyak V.	Skilled Support Staff
176	Smt. Arathy R Pillai	Skilled Support Staff
CALICUT RESEARCH CENTRE		
177	Ms. Nishida P.	Skilled Support Staff
178	Shri M.K. Chandran	Skilled Support Staff
179	Shri P. Satheeshkumar	Skilled Support Staff
180	Shri M.P. Devadasan	Skilled Support Staff
181	Shri P.V. Gopalan	Skilled Support Staff
182	Shri P.B. Jeevaraj	Skilled Support Staff
183	Shri V. Rajendran	Skilled Support Staff
184	Shri Anirudh K	Skilled Support Staff
KVK NARAKKAL		
185	Jimosh Mohan C M	Skilled Support Staff
186	Shri Midhun Kumar P.H	Skilled Support Staff
KVK LAKSHADWEEP		
187	Shri Abdul Hakeem M.M	Skilled Support Staff
188	Smt.Shajala Banu P.M	Skilled Support Staff

Research Projects

In House

Sl. No	Project Code	Title of the Project	PI of the Project & Division	Co-PIs	Duration
1	FRA/GIS/01	Geo-referenced online information system for marine fisheries on GIS platform to formulate management strategies for sustainable harvest of resources	Dr. T.V. Sathianandan FRAD	Dr. J. Jayasankar Dr. Somy Kuriakose Dr. Mini K.G. Dr. Grinson George Shri Vinaykumar Vase Shri Vivekanad Bharti Dr. Eldho Varghese Shri Wilson T. Mathew	2017-2024
2	FRA/CHL/02	Chlorophyll based Remote sensing assisted Indian marine Fisheries Forecasting System (ChloRIFFS)	Dr. J. Jayasankar FRAD	Dr. T.V. Sathianandan Dr. Prathibha Rohit Dr. Somy Kuriakose Dr. K.G. Mini Dr. R. Jeyabaskaran Dr. Grinson George Dr. Eldho Varghese Shri Vinaykumar Vase Shri Vivekanad Bharti	2017-2020
3	PEL/RMS/03	Resource assessment and management framework for sustaining marine fisheries of Karnataka and Goa	Dr. Prathibha Rohit PFD	Dr. A.P. Dineshbabu Dr. Sujitha Thomas Dr. Geetha Sasikumar Dr. K. M. Rajesh Dr. Bindu Sulochanan Dr. G. B. Purushottama Smt Divya Viswambharan Dr. K.G. Mini Dr. P.S. Swathilekshmi Dr. P. Shinoj	2017-2024
4	PEL/LPR/04	National fishery management framework for large pelagic resources	Dr. E. M. Abdussamad PFD	Shri K. P. Said Koya Dr. Prathibha Rohit Dr. M. Sivadas Dr. A. Margaret Muthu Rathinam Dr. U. Ganga Dr. Shubhadeep Ghosh Dr. K. M. Rajesh Shri K. Mohammed Koya	2017-2020

Research Projects: In House

Sl. No	Project Code	Title of the Project	PI of the Project & Division	Co-PIs	Duration
				Dr. Anulekshmi Chellappan Smt S. Surya Shri Nakhawa Ajay Dayaram Shri Subal Kumar Roul Shri P. Abdul Azeez Shri R. Vinoth Kumar Smt Shikha Rahangdale Shri K. M. Manas Dr. K.G. Mini	
5	PEL/NEC/05	Resource assessment and management framework for sustaining marine fisheries of the West Bengal and Odisha	Dr. Gyanaranjan Dash PFD	Subal Kumar Roul Swatipriyanka Sen Dash Rajesh Kumar Pradhan Vivekananda Bharathi Shyam S Salim	2017-2022
6	PEL/LAK/06	Resource assessment and management framework for sustaining marine fisheries of the fishery of Lakshadweep	Shri K. Mohamed Koya PFD	Dr. K. M. Rajesh Shri P. G. Ambarish Shri K. P. Said Koya Shri Subal Kumar Roul Shri P. Abdul Azeez Smt S. Surya Dr. Prathibha Rohit Dr. E. M. Abdussamad Dr. M. Sivadas Dr. P Shinoj Shri Vivekanad Bharti Dr. P.S. Swathilekshmi Dr. K. R. Sreenath Dr. U. Ganga Smt Remya Raj	2017-2020
7	DEM/RMS/07	Resource assessment and management framework for sustaining marine fisheries of Kerala	Dr. T. M. Najmudeen DFD	Dr. P. U. Zacharia Dr. Rekha J. Nair Dr. Livi Wilson Shri P. G. Ambarish Dr. V. Mahesh Dr. E. M. Abdussamad Dr. U. Ganga Shri Subal Kumar Roul Shri K. P. Said Koya Smt S. Surya Dr. G. Maheswarudu Dr. Josileen Jose	2017-2024

Research Projects: In House

Sl. No	Project Code	Title of the Project	PI of the Project & Division	Co-PIs	Duration
				Dr. S. Lakshmi Pillai	
				Dr. Rekha Devi Chakraborty	
				Dr. K. N. Saleela	
				Dr. V. Venkatesan	
				Dr. R. Vidya	
				Dr. P. K. Asokan	
				Dr. P. Gomathi	
				Dr. V. Kripa	
				Dr. D. Prema	
				Dr. Shelton Padua	
				Dr. Somy Kuriakose	
				Dr. N. Aswathy	
				Dr. M. K. Anil	
				Shri K. Mohamed Koya	
	DEM/RMS/SUB/07	Monitoring and assessment of juvenile fishery along the coast of Kerala	Dr. T. M. Najmudeen DFD	Dr. P. U. Zacharia	2017-2020
				Dr. T. V. Sathianandan	
				Dr. S. Lakshmi Pillai	
				Smt Livi Wilson	
				Dr. V. Venkatesan	
				Dr. V. Mahesh	
				Shri P. G. Ambarish	
				Dr. K. N. Saleela	
				Shri Subal Kumar Roul	
				Dr. Shyam S. Salim	
8	PEL/RMS/08	Resource assessment and management framework for sustaining Marine Fisheries of Tamil Nadu and Puducherry	Dr. M. Sivadas PFD	Dr. Shoba Joe Kizhakkudan	2017-2024
				Dr. A. Margaret Muthu Rathinam	
				Dr. P. T Sarada	
				Ms. E. M. Chhandaprajnadarsini	
				Dr. P. P Manoj Kumar	
				Dr. I. Jagadis	
				Ms. M. Kavitha	
				Smt Shikha Rahangdale	
				Shri Rajan Kumar	
				Shri R. Vinoth Kumar	
				Smt L. Remya	
				Shri M. Rajkumar	
				Dr. K. N. Saleela	
				Dr. R. Narayanakumar	
				Dr. Grinson George	

Research Projects: In House

Sl. No	Project Code	Title of the Project	PI of the Project & Division	Co-PIs	Duration
9	DEM/RMS/09	Resource assessment and management framework for sustaining marine fisheries of Gujarat	Dr. Vinaykumar Vase FRAD	Smt Shikha Rahangdale Shri P. Abdul Azeez Shri Rajan Kumar Dr. Kapil S Sukhdhane Shri Tarachand Kumawat	2017-2022
10	DEM/RMS/10	Resource assessment and management framework for sustaining marine fisheries of Andhra Pradesh	Smt M. Muktha DFD	Dr. Shubhadeep Ghosh Dr. Indira Divipala Ms F. Jasmin Shri L. Loveson Edward Dr. S. S. Raju Shri K. M. Manas Dr. Eldho Varghese	2017-2024
11	DEM/ELS/11	Developing management plans for sustainable exploitation and conservation of elasmobranchs in India	Dr. Shoba Joe Kizhakudan DFD	Dr. Sujitha Thomas Dr. P. U. Zacharia Dr. P. P. Manoj Kumar Dr. Rekha J Nair Dr. T. M. Najmudeen Smt Muktha Menon Dr. G. B. Purushothama Dr. Swatipriyanka Sen Dr. K. V. Akhilesh Smt Remya L Smt. Livi Wilson Shri P. G. Ambarish Dr. V. Mahesh Dr. Shikha Rahangdale Shri Subal Kumar Roul Dr. Shyam. S. Salim Dr. Rajesh Kumar Pradhan	2017-2020
	DEM/ ELS/SUB/11	Assessing the status of elasmobranchs protected under the Indian Wildlife (Protection) Act 1972	Dr. K. V. Akhilesh DFD	Dr. Shoba Joe Kizhakudan Dr. Sujitha Thomas Dr. P. U. Zacharia Dr. P. P. Manoj Kumar Dr. Rekha J Nair Dr. T. M. Najmudeen Smt Muktha Menon Dr. G. B. Purushothama Dr. Swatipriyanka Sen Dr. K.V. Akhilesh Smt L. Remya Smt Livi Wilson Shri P. G. Ambarish	2017-2020

Research Projects: In House

Sl. No	Project Code	Title of the Project	PI of the Project & Division	Co-PIs	Duration
				Dr. V. Mahesh Dr. Shyam. S. Salim Shri Rajesh Kumar Pradhan	
12	CFD/BPT/12	Development of guidelines for "Best practices" for trawl fishery in India	Dr. A.P. Dineshbabu CFD	Dr. Sujitha Thomas Dr. Anulekshmi Chellappan Dr. Indira Divipala Dr. Shubhadeep Ghosh Dr. Gyanranjan Dash Dr. Swathipriyanka Sen Shri. Rajesh Kumar Pradhan Dr. K. V. Akhilesh Shri R. Ratheeshkumar Shri Nakhava Ajay D Dr. K. M Rajesh Dr. Purushottama G. B. Dr. Mahesh V. Dr. G. Maheswarudu Dr. Josileen Jose Dr. S. Lakshmi Pillai Dr. Rekha Devi Chakraborty Dr. T. M. Najmudeen Shri M. Rajkumar Shri Rajan Kumar Dr. P. T. Sarada Dr. M. Sivadas Dr. Shoba Joe Kizhakudan Smt. Shikha Rahandgale Dr. R. Narayanakumar Dr. P. S. Swathilekshmi	2017-2020
13	CFD/RMS/13	Resource Assessment and Management framework for sustaining marine fisheries of Maharashtra	Dr. Anulekshmi Chellappan PFD	Dr. S. Ramkumar Dr K. V. Akhilesh Shri R. Ratheesh Kumar Shri Ajay D. Nakhawa Shri Santhosh N. Bhendekar Dr. Somy Kuriakose Dr. Shyam S. Salim	2017-2024
14	CFD/REC/14	Implications of recruitment dynamics and spatio-temporal stock assessment of marine prawns of India for fisheries management	Dr. P. T. Sarada CFD	Dr. G. Maheswarudu Dr. S. Lakshmi Pillai Dr. Rekha Devi Chakraborty Dr. K. N. Saleela Dr. A. P. Dineshbabu Shri. R. Ratheesh Kumar	2017-2020

Research Projects: In House

Sl. No	Project Code	Title of the Project	PI of the Project & Division	Co-PIs	Duration
				Dr. Gyanranjan Dash Dr. Indira Divipala Shri. M. Rajkumar Shri. Rajan Kumar	
	CFD/REC/SUB/14	Investigations on commercial lobster fishing and live lobster trade in India	Dr. K. N. Saleela CFD	Dr. P. T. Sarada Dr. Rekha Devi Chakraborty Dr. Gyanranjan Dash Shri. R. Ratheesh Kumar Shri. M. Rajkumar Shri. Rajan Kumar	2017-2020
15	MFD/BIV/15	Fishery Management Plans (FMPs) and recruitment dynamics of bivalves	Dr. Geetha Sasikumar MFD	Dr. K. S. Mohamed Dr. P. K. Asokan Dr. I. Jagadis Dr. V. Venkatesan Dr. R. Vidya Smt F. Jasmin Smt M. Kavitha Smt E. M. Chhandapranjandarsini Smt. P. Gomathi Shri Bhandekar Santhosh Nagnath	2017-2024
16	MFD/GTR/16	Assessment of ornamental gastropod fisheries and studies on the shellcraft industry in India	Dr. I. Jagadis MFD	Dr. V. Venkatesan Dr. Shyam S. Salim Smt M. Kavitha Smt F. Jasmin Smt E. M. Chhandaprajnadarsini Shri Rajesh Kumar Pradhan	2017-2020
17	MFD/MOL/17	Popularizing eco-friendly molluscan farming strategies	Dr. P. K. Asokan MFD	Dr. K. S. Mohamed Dr. I. Jagadis Dr. M. K. Anil Dr. Geetha Sasikumar Dr. V. Kripa Dr. P. Kaladharan Dr. V. P. Vipinkumar Dr. R. Vidya Dr. N. S. Jeena Shri Santosh Nagnath Bhendekar Smt E. M. Chhandaprajnadarsini Smt M. Kavitha Shri Rajesh Kumar Pradhan	2017-2024

Research Projects: In House

Sl. No	Project Code	Title of the Project	PI of the Project & Division	Co-PIs	Duration
18	MDN/HCY/18	Development of hatchery technologies for commercially important species in mariculture	Dr. R. Jayakumar MCD	Dr. Imelda Joseph Dr. K. Madhu Dr. Rema Madhu Dr. Gulshad Mohammed Dr. Boby Ignatius Dr. Shoji Joseph Dr. Joe K. Kizhakudan Dr. B. Santhosh Dr. A.K. Abdul Nazar Dr. Jayasree Loka Dr. T. Senthil Murugan Dr. G. Tamilmani Dr. P.P. Sureshbabu Dr. M. Sakthivel Dr. Ritesh Ranjan Shri C. Kalidas Dr. P. Rameshkumar Dr. Biji Xavier Shri N. Rajesh Dr. D. Divu Dr. Sekar Megarajan Dr. K. K. Anikuttan Smt M.T. Shilta Shri M. Sankar Shri S. Chandrasekhar Shri Sanal Ebeneezar	2017-2024
19	MDN/CGE/19	Innovations in Sea cage farming and coastal mariculture	Dr. Imelda Joseph MCD	Dr. Jayasree Loka Dr. T. Senthil Murugan Smt. Saloni Shivam Shri K. Reghu Ramudu Dr. A. K. Abdul Nazar Dr. R. Jayakumar Dr. G. Tamilmani Dr. P. Rameshkumar Dr. M. Shaktivel Dr. B. Johnson Dr. K. K. Anikuttan Shri M. Sankar Dr. Ritesh Ranjan Dr. Biji Xavier Dr. Sekar Megarajan Shri D. Linga Prabu	2017-2020

Research Projects: In House

Sl. No	Project Code	Title of the Project	PI of the Project & Division	Co-PIs	Duration
				Dr. K. Madhu Dr. Rema Madhu Dr. Boby Ignatius Dr. Shoji Joseph Shri. N. Rajesh Dr. N. Aswathy Shri K. Anuraj Dr. A. P. Dinesh Babu Dr. Sujitha Thomas Dr. Joe K. Kizhakudan Dr. D. Divu Shri V. Vinaykumar Dr. Gulshad Mohammed Dr. P. P. Sureshbabu Smt M.T. Shilta Dr. P. P. Manoj Kumar Shri C. Kalidas Dr. B. Santhosh Dr. M.K. Anil	
20	MDN/REP/20	Analysis of reproductive characteristics of selected potential species for mariculture	Dr. Shoji Joseph MCD	Dr. Imelda Joseph Dr. Boby Ignatius Dr. B. Santhosh Dr. P.P. Suresh Babu Dr. Jayasree Loka Dr. A. K. Abdul Nazar Dr. K. K. Anikuttan Dr. M. Sakthivel Dr. G. Tamilmani Smt. Muktha Menon Shri N. Rajesh Smt M. T. Shilta	2017-2020
21	MDM/FAD/21	Assessing the performance of artificial reefs deployed along north Tamil Nadu coast	Dr. Joe K. Kizhakudan MCD	Dr. P. Laxmilatha Dr. R. Narayanakumar Dr. Shoba Joe. Kizhakudan	2017-2020
22	MDN/GRO/22	Delineating the compensatory growth pattern in stunted fingerlings of marine finfishes for production enhancement	Dr. Suresh Babu P. P. MCD	Dr. Imelda Joseph Dr. Boby Ignatius Dr. R. Jayakumar Smt M. T. Shilta Dr. P. Shinoj Dr. A. K. Abdul Nazar Dr. K. K. Anikuttan Shri M. Shankar Shri A. Anuraj	2017-2020

Research Projects: In House

Sl. No	Project Code	Title of the Project	PI of the Project & Division	Co-PIs	Duration
23	MBT/HLT/23	Health management in selected finfish and shellfish and bio-prospecting from marine resources	Dr. N. K. Sanil MBTD	Dr. Sandhya Sukumaran Dr. M. A. Pradeep Dr. P. K. Asokan Dr. S. R. Krupesha Sharma Dr. M. K. Anil Dr. Joe K. Kizhakudan Dr. Ritesh Ranjan Dr. P. Rameshkumar Smt K. J. Reshma Dr. T. G. Sumithra Ms. S. Saloni Shivam Smt Saima Rehman Shri Reghu Ramudu Dr. Jayasree Loka	2017-2020
	MBT/HLT/SUB 23	Development of bioactive pharmacophores from marine organisms	Dr. Kajal Chakraborty MBTD		2017-2020
24	MBT/NTM/24	Marine food fish, ornamental fish and lobster nutrition research for mariculture	Dr. P. Vijayagopal MBTD	Dr. Boby Ignatius Dr. Joe K. Kizhakudan Dr. C. P. Suja Dr. Vidya Jayasankar Dr. Kajal Chakraborty Shri C. Kalidas Shri D. Linga Prabu Shri S. Chandrasekar Shri Sanal Ebeneezar Shri Adnan Hussain Gora Smt K. J. Reshma Dr. T. G. Sumithra	2017-2020
25	MBT/GEN/25	Genetic and genomic approaches for fishery resource management, conservation and sustainable mariculture	Dr. Sandhya Sukumaran MBTD	Dr. A. Gopalakrishnan Shri V. Srinivasa Raghavan Dr. N. S. Jeena Dr. Sekar Megarajan	2017-2020
26	MBT/TSU/26	Biomineralization of mantle tissue from pearl producing molluscs	Dr. C. P. Suja MBTD	Dr. Vidya Jayasankar Shri Srinivasa Raghavan V.	2017-2018

Research Projects: In House

Sl. No	Project Code	Title of the Project	PI of the Project & Division	Co-PIs	Duration
27	FEM/HBT/27	Micro-level environmental management plans for selected critical habitats for ecosystem health and sustainable production	Dr. D. Prema FEMD	Dr. V. Kripa Dr. Shelton Padua Dr. R. Jeyabaskaran Dr. Reeta Jayasankar Dr. P. S. Asha Dr. Bindu Sulochanan Shri Loveson Edward Shri K. S. Sukhdhane Shri S. Thirumalaiselvan Smt Ramya Abhijith Dr. R. Narayanakumar Dr. K. Sunil Kumar Mohamed Dr. P. Kaladharan	2017-2020
	FEM/HBT/SUB/27	Impact of climate extremes and disasters on ecosystem functioning with special emphasis on fisheries and mariculture	Dr. V. Kripa FEMD	Dr. K Sunil Kumar Mohamed Dr. D Prema Dr. R Jayabaskaran Dr. Shelton Padua	2017-2020
28	FEM/PLN/28	Abatement of coastal pollution through bioremediation	Dr. Reeta Jayasankar FEMD	Dr. D. Prema Dr. P. Kaladharan Dr. K. Vijayakumaran Dr. P. S. Asha Dr. Bindu Sulochanan Shri Loveson Edward Shri K. S. Sukhdhane Shri S. Thirumalaiselvan	2017-2020
	FEM/PLN/SUB/28	Assessment of coastal and marine pollution in selected maritime states of India	Dr. P. S. Asha FEMD	Dr. D. Prema Dr. R. Jeyabaskaran Dr. Bindu Sulochanan Shri Loveson Edward Shri K. S. Sukhdhane Dr. Shelton Padua Shri S. Thirumalaiselvan Smt Ramya Abhijith	2017-2020
29	FEM/MPH/29	Marine macrophytes in India-resources dynamics and ecosystem services	Dr. P. Kaladharan FEMD	Dr. R. Narayanakumar Dr. R. Jeyabaskaran Dr. K. Vijayakumaran Dr. B. Johnson Shri Thirumalaiselvan S. Shri K. S. Sukhdhane Smt Remya Abhijith Dr. Reeta Jayasankar	2017-2020

Research Projects: In House

Sl. No	Project Code	Title of the Project	PI of the Project & Division	Co-PIs	Duration
				Shri Loveson Edward	
30	MBD/CNS/30	Developing Conservation plan for biologically sensitive areas along the Indian coast	Dr. K. Vinod MBD	Dr. K. K. Joshi Dr. R. Narayanakumar Dr. Molly Varghese Dr. S. Jasmine Dr. K. S. Sobhana Dr. Miriam Paul Sreeram Dr. K. R. Sreenath Shri Saravanan R Shri L. Renjith Shri S. Ramkumar Dr. Pralaya Renjan Behera Dr. Divya Viswambharan Shri Tarachand Kumawat	2017-2020
31	MBD/CRL/31	Assessment of resilience potential of coral reefs	Dr. K. R. Sreenath MBD	Dr. K. K. Joshi Dr. S. Jasmine Dr. P. Laxmilatha Dr. K. S. Sobhana Dr. Molly Varghese Dr. K. Vinod Dr. Miriam Paul Sreeram Shri Saravanan R Shri L. Renjith Shri S. Ramkumar Dr. Pralaya Renjan Behera Dr. Divya Viswambharan Shri Tarachand Kumawat Shri. K. Mohammed Koya	2017-2024
32	MBD/JLY/32	Investigations on the scyphozoan and cubozoan jellyfishes diversity and distribution along the Indian coast	Dr. R. Saravanan MBD	Dr. S. Jasmine Dr. P. Laxmilatha Dr. K. Vinod Dr. K. S. Sobhana Dr. Miriam Paul Sreeram Dr. K. R. Sreenath Shri Tarachand Kumawat Shri L. Renjith Dr. Divya Viswambharan Dr. Pralaya Renjan Behera Shri S. Ramkumar	2017-2020

Research Projects: In House

Sl. No	Project Code	Title of the Project	PI of the Project & Division	Co-PIs	Duration
33	SEE/SOC/33	Socio-economic assessment of marine fisheries resource use and management in India	Dr. R. Narayanakumar SEETTD	Dr. S. S. Raju Dr. C. Ramachandran Dr. Shyam S. Salim Dr. P. S. Swathilekshmi Dr. N. Aswathy Dr. B. Johnson Dr. P. Shinoj	2017-2024
34	SEE/GOV/34	Responsible Marine fisheries governance: Compliance analysis and peripatetic capacity development	Dr. C. Ramachandran SEETTD	Dr. P. Shinoj Dr. S. S. Raju Dr. V. P. Vipinkumar Dr. B. Johnson Shri Tarachand Kumawat	2017-2020
	SEE/GOV/SUB/34	A study on compliance to fishery regulations along the Indian coastline	Dr. P. Shinoj SEETTD	Dr. C. Ramachandran Dr. S.S. Raju Dr. V. P. Vipinkumar Dr. B. Johnson Shri Tarachand Kumawat	2017-2020
35	SEE/DCD/35	Marine fish distribution and consumption demand in India : A policy outlook	Dr. Shyam S. Salim SEETTD	Dr. R. Narayanakumar Dr. V. P. Vipinkumar Dr. S. S. Raju Dr. P. S. Swathilekshmi Dr. Swatipriyanka Sen Dash Dr. T. V. Sathianandan	2017-2024
36	SEE/GEN/36	Alternate livelihood options and gender mainstreaming for entrepreneurship development in marine fisheries sector of India	Dr. P. S. Swathilekshmi SEETTD	Dr. R. Narayanakumar Dr. V. P. Vipinkumar Dr. Shyam S. Salim Dr. Reeta Jayasankar Dr. B. Johnson Dr. Nikita Gopal (CIFT)	2017-2020
	SEE/GEN/SUB/36	Mainstreaming the gender perspective of SHGs in Indian fisheries sector	Dr. V. P. Vipinkumar SEETTD	Dr. R. Narayanakumar Dr. P. S. Swathilekshmi Dr. Shyam. S. Salim Dr. Reeta Jayasankar Dr. C. Ramachandran Dr. N. Aswathy	2017-2020
37	MBT/DNA/37	Environmental DNA (eDNA) Metabarcoding – based estimation of marine stocks	Dr. P. Jayasankar MBTD	Dr. K. G.Mini Dr. M. A. Pradeep	2017-2019

Research Projects

Externally Funded

Sl. No.	Title of the Project	Principal Invetigator	Funding Agency	Duration	Total cost (` lakhs)
1	National Surveillance project on aquatic animal diseases	Dr. N. K. Sanil	NFDB	2015-2018	122.01
2	Genetic tagging of spawning populations of Indian oil sardine, *Sardinella longiceps* along South west coast of India using microsatellite markers	Dr. Sandhya Sukumaran	KSCSTE	2015-2018	24.5
3	Development of small molecular weight angiotensin II converting enzyme inhibitors from marine organisms	Dr. Kajal Chakraborty	DBT	2017-2020	54
4	AINP on Fish Health	Dr. N.K. Sanil	ICAR	2017-2020	51
5	Fish Genetic stocks	Dr. A. Gopalakrishnan	ICAR	2012-2019	100
6	National Initiative on Climate Resilient Agriculture (NICRA)	Dr. P.U. Zacharia	ICAR	2012-2018	249
7	Network project on fish health	Dr. N. K. Sanil	ICAR	2015-2020	--
8	Consortium Research project on diagnostics and vaccines	Dr. N. K. Sanil	ICAR	2015-2020	363.16
9	Network Programme on Assessment of Antimicrobial Resistance (AMR) in Microorganisms Associated with Fisheries and Aquaculture in India	Dr. K.R. Krupesha Sharma	Network Project - AMR	2018	--
10	CDRRP-FIMSUL - 2017-2018	Dr. T. V. Sathianandan			98
11	A model for the primary production in Indian Coastal Waters	Dr. Grinson George	DST	2017-2020	48.26
12	CO_2 assimilation off Cochin and Mandapam coast	Grinson George	NRSC	2017-2020	48
13	Derivation and characterization of Embryonic Stem (ES) cell lines from the marine ornamental maroon clown fish *Premnas biaculeatus* and induced Pluripotent Stem (iPS) cell lines from the humpback grouper *Chromileptes altivelis*	Dr. K.S. Sobhana	DBT	2015-2018	64.3
14	Molecular taxonomy and phylogeny of Cones (Cone snails) and Strombs (Mollusca, Gastropoda) of the Indian coast	Dr. P. Laxmilatha	DBT	2015-2018	58.53
15	Valuation of marine & coastal ecosystem in Kadalundi Community Reserve of Kerala	Dr. K. Vinod	KSBB	2017-2018	9
16	Taxonomical Investigation of Lesser known marine animals of India - Phylum: Cnidaria (Class: Anthozoa) and Phylum: Porifere (Marine)	Dr. K. K. Joshi	MoEF&CC	2018-2021	20.38
17	Global learning for local solution: Reducing vulnerability of marine dependent coastal communities	Dr. A. Gopalakrishnan	Belmont Forum through MoES	2013-2018 (Extended)	165.75

Research Projects: Externally Funded

18	Policy Imperatives for Promoting Value Chains of Agricultural Commodities in India"	Dr. Shinoj and Dr. C. Ramachandran	Network project with National Institute of Agricultural Economics and Policy Research (NIAP)	2017*-2020 (Commenced at CMFRI in January 2018 only)	34
19	Assessing the financial viability/ sustainability of Theeramythri enterprises	Dr. Shyam S. Salim	SAF, Department of Fisheries. Government of Kerala	2018-2019* (Commenced from March 2018 only)	5
20	Fish Market and Price Information System (FMPIS)	Dr. Shyam S. Salim	NFDB-E-market	2019-2020 (1 year)	189
21	Fisher welfare impact assessment on the satellite based ocean information services: an appraisal	Dr. Shyam S. Salim	INCOIS	01/04/2018 to 31/03/2020	20.22
22.	Advanced Phytoplankton Cultivation Method for hatchery feed with special emphasis on mussel seed production	Dr. M.K. Anil	KSCSTE	2016-2018	10
23.	Benchmarks for Ecosystem Assessment : Indicators and guidelines for practical Ecosystem Based Fishery Management (EBFM)	Dr. Sunilkumar Mohamed	CSIRO	2018-2021	44
24.	Piloting and upscaling of PAN India Fisher Friend Mobile Application in Karnataka	Dr. Prathbha Rohit	MSSRF	2017-2018	6
25.	Impact, Vulnerability and Adaptation Strategies for marine fisheries of India	Dr. A. Gopalakrishnan	NATCOM	2016-2019	25.3
26.	Identification, forecasting and monitoring of Potential Fishing Zone for Tamilnadu coastal and offshore waters (SAMUDRA TDP R&D)	Dr. Shoba Joe Kizhakudan	SAC-ISRO	2017-2019	33.7
27.	AINP on Mariculture	Dr. Boby Ignatius	ICAR	2017-2020	1025
28.	Enhancing production of farmed Cobia (*Rachycentron canadum*) through the establishment of broodbank and supply of larvae to States for seed production	Dr. A. K. Abdul Nazar	NFDB	2016-2020	813.8
29.	Enhancing production of farmed Silver Pompano through the establishment of broodbank, supply of larvae to States for seed production	Dr. M. K. Anil	NFDB	2016-2020	843
30.	Open water cage culture in selected District in Kerala and Karnataka	Dr. Imelda Joseph	NFDB	2017-2019	1328.7
31.	Cage culture demonstration of Orange Spotted grouper (*Epinephelus coioides*) in Andhra Pradesh using CMFRI technology	Dr. Shubhadeep Ghosh,	NFDB	2017-2018 (2 years)	370.8
32.	Demonstration of pond culture technology for two high value marine fin fishes in salt affected areas of Andhra Pradesh by ICAR-CMFRI	Dr. Sekar Megarajan	NFDB	2018-2020 (2 years)	65.02
33.	Hands on training programme on Live-Feed Production technologies for marine finfish and shellfish	Dr. Ritesh Ranjan	NFDB	2018-2019 (1 year)	5.7
34.	Network Project on ornamental fish breeding and culture	Dr. K. Madhu	Network Project	2018-2023	--

Research Projects

Consultancy

Sl. No.	Client	Project	Amount (In Lakhs)
1	Director of Fisheries, Dept. Of Fisheries, Tamil Nadu	Installation of artificial reefs in the inshore waters of seventeen villages along Tamil Nadu coast	260.8
2	The Project Director, IFAD assisted PTSLP TN Corpn. for development of women, 100 Anna Salai Rd, Guindy, Chennai	Consultancy on livelihood enhancement of fishermen through deployment of AR in inshore waters along the six districts of TN	92.98
3	The Gujarat Livelihood Promotion Company Ltd., Block-18, 3rd Floor, Sector – 11, Udhyog Bhavan, Gandhinagar – 382 011. GUJARAT	Feasibility study for commercial scale seaweed cultivation in Gujarat under project Sagar Lakshmi	10
4	Commissioner of Fy. Commissionerate of Fy. Third Floor, Block No.10, Jivraj Mehta Bhavan, Gandhi Nagar, Gujarat	Artificial fish habitat based marine ecosystem restoration in the inshore areas off Bhadreshswar, Kutch District, Gujarat.	359.37
5	Chief Executive Officer, Dept. of Fisheries, UT of Lakshadweep, Kavaratti- 682 555	Setting up of Modern Aquarium at Dept. of Fisheries, UT of Lakshadweep, Kavaratti.	54.7
6	M/s JSW Jaigarh Port Limited, JSW Centre, Bandra Kurla Complex, Mumbai -400051	Assessment of impact on fish production due to development of the Jaigarh Port at Village Jaigarh, Maharashtra,	49.91
7	Jawaharlal Nehru Port Trust, Mumbai	Impact study of proposed Vadhavan Port on coastal fisheries	94.08
8	M/s IntensAquatica Pvt. Ltd., BANGALORE	Technology support for seed production of orange spotted grouper, Epinephelus coioides	6.62
9	Anjana Sterilants, Vichoor, Chennai-103	Quality testing of a novel disinfectant against fish pathogens	0.91
10	Adani foundation Mundra, Kutch	Empowerment of the Pagadia fishermen of the Sekhadiya Village (Juna Bunder), Kutch District, Gujarat through sustainable marine cage farming	10
11	Marine water quality monitoring at SPM area of M/s MRPL-(2)	MRPL Mangalore	5.01
12	MRPL, Mangalore	Sea water and treated effluent monitoring of M/s MRPL	13.68
	TOTAL		958.06

Research Management & Staff welfare

Research Advisory Committee (RAC)

The 23rd RAC of CMFRI met from 11-12 March 2018. Dr. Madan Mohan, Driector of Fisheries and former ADG (Marine Fisheries) assuming the Chairmanship consequent to the demise of Dr. N. R. Menon.

1. 25th IRC meeting of CMFRI

The meeting was attended by,

1.	Dr. Madan Mohan, ADG (Marine Fisheries, Retd.) ICAR, New Delhi & Director of Fisheries, Punjab	Chairman
2.	Dr. A.R. Thirunavukkarasu, Principal Scientist (Retd.), CIBA, Chennai,	Member
3.	Dr. V.N. Sanjeevan, former Director Centre for Marine Living Resources, Kochi,	Member
4.	Dr. N. Ramaiah, Scientist (Retd.), NIO, Goa,	Member
5.	Dr. Pravin Puthra, ADG (Marine Fisheries), ICAR, New Delhi,	Member
6.	Mr. K. Muraleedharan,	IMC Member
7.	Mr. K.P. Hariharan,	IMC Member
8.	Dr. A. Gopalakrishnan, Director, CMFRI,	Member
9.	Dr. P. Vijayagopal, PS and Head in Charge Marine Biotechnology Division (MBTD),	Member Secretary
10.	Dr. K. S. Mohmed, PS and Head-in-charge, Molluscan Fisheries Division (MFD)	
11.	Dr. V. Kripa, PS and Head-in-charge, Fishery Environment Management Division (FEMD)	
12.	Dr. Maheswarudu, G. PS and Head-in-charge, Crustacean Fisheries Division (CFD)	
13.	Dr. T. V. Sathianandan, Head of Division, Fisheries Resources Assessment Division (FRAD)	
14.	Dr. K. K. Joshi, Head of Division, Marine Biodiversity Division (MBD)	
15.	Dr. Prathibha Rohit, PS and Head-in-charge, Pelagic Fisheries Division (PFD), Scientist-in-Charge (SIC), Mangalore Research Centre	
16.	Dr. R. Naryanakumar, PS and Head-in-charge, Socio-Economic Evaluation and Transfer of Technology Division (SEETTD)	
17.	Dr. Imelda Joseph, PS and Head-in-Charge, Mariculture Division (MD)	
18.	Dr. P.K. Asokan Scientist-in-Charge, Calicut Research Centre	
19.	Dr. M. K. Anil, Scientist-in-Charge, Vizhinjam Research Centre	
20.	Dr. Jayasree Loka, Scientist-in-Charge, Karwar Research Centre	
21.	Dr. Anulekshmi Chellappan, Scientist-in-Charge, Mumbai Research Centre	
22.	Dr. Divu Damodaran, Scientist-in-Charge, Veraval Regional Centre	
23.	Dr. Shubhadeep Ghosh, Scientist-in-Charge, Visakhapatnam Research Centre	
24.	Dr. Subal Kumar Roul, Scientist-in-Charge, Puri Field Centre	
25.	Dr. Gyanaranjan Dash, Scientist-in-Charge, Digha Research Centre	
26.	Dr. P.P. Manoj Kumar Scientist-in-Charge, Tuticorin Research Centre	
27.	Dr. Jayakumar R. Scientist-in-Charge, Mandapam Regional Centre	
28.	Dr. P. Laxmilatha Scientist-in-Charge, Madras Research Centre	
29.	Dr. Shinoj Subramannian, Programme Coordinator, KVK, Ernakulam	
30.	Dr. Boby Igantius Scientist-in-Charge, HRD Cell	
31.	Mrs. P. Geetha Officer-in-Charge, Library and Documentation	

The meeting began with a short formal welcome by Dr. Vijayagopal, Member Secretary followed by homage to Dr. N. R. Menon, former Chairman of the RAC who passed away on 17th March 2018 two days after chairing the 22nd RAC of CMFRI. The RAC also paid homages to Dr. E. G. Silas, former Director CMFRI and the martyrs of Pulwama. Dr. A. Gopalakrishan presented the Institutes activities and achievements during the year 2018-19. This was followed by the opening remarks by the RAC Members and the Chairman The action taken report of the 22nd RAC was presented by the Member Secretary in which the action points which needed to be carried over we indicated. Presentations by the Head of Divisions followed with detailed deliberations and recommendations made were documented for action.

Recommendations of the 22nd RAC

1. Bring out more user friendly mobile apps for stakeholders/ target groups

2. Complete all targets indicated in EFC document within the time frame. Initiate steps to complete pending targets

3. Collect data on picoplankton from cage culture site as they for the food for larvae and zooplankton

4. Equip database on the economics of cage culture and environmental parameters at culture site – cage/ pen etc. and make readily available as and when required

5. Collect time series data on in situ data at all centeres – fish eggs, larvae, size class of phytoplankton and composition of zooplankton fro

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interpreting changes happending in the ecosystem

6. Make available all technologies developed by CMFRI in e-portal

7. Explore possibilities of collaborative projects with sister institutes – CIFT and CIFRI at headquarters and Centers. This can check overlapping of same work by different Institutes and also utilize expertise available with other ICAR Institutes

8. Initiate steps to popularize fish consumption by general public as available for egg and milk

9. For doubling farmers income, CMFRI should look into wealth from waste

10. Study the abundance of jelly fishes in the ecosystem in relation to trophic changes

11. As the scientific strength of CMFRI is 150, each scientist should produce at least 2 papers/year in refereed journals so as to generate 300 papers for the Institute

12. Document the changes that happened post Ochi – silt accumulation changes in marine biodiversity etc. along southern Kerala coast.

Institute Research Council (IRC)

The 25th Institute Research Council (IRC) Meeting was held at CMFRI Headquarters from 4th to 8th June 2018 (5 days). On the first day, meetings were conducted at respective Divisions as per the schedule of the 25th IRC. Dr. K.S. Mohamed, IRC Member Secretary, wholeheartedly welcomed the Chairman and all the IRC members to the 25th IRC meeting. He appreciated the scientists for their sincere efforts for being present though this year IRC was delayed. He also added that meeting is commencing same day with the new academic year, the monsoon is in full swing and northern Kerala is facing serious issues of Nipah Virus outbreak. In spite of these inconveniences all the members could be present for this important annual meeting.

Secretary told that before the commencement of the IRC proceedings, the members should pay homage and respect to two former eminent scientists who passed away recently, Dr. E. G Silas former Director of CMFRI & doyen of marine fisheries and Prof. (Dr.) N. R. Menon, Chairman, RAC, CMFRI. All the members stood up and observed silence for a minute as a tribute to the departed souls. Dr. Mohamed warmly welcomed three new members of the IRC, Dr. Eldho Varghese (FRAD, Cochin), Dr. Anuraj, A. (Mariculture Division, Karwar) and Shri. Manas K. M., (PFD, Visakhapatnam), who are attending the IRC for the first time. He also informed that this year two of our eminent scientists, Dr. V. V. Singh, SIC

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1. 23rd RAC Meeting of CMFRI
2. IMC meeting at CMFRI
3. IJSC meeting at CMFRI

of Mumbai RC and Dr. K. Vijayakumaran, Principal Scientist, FEMD at Madras R.C., are leaving us and greeted them specially as both of them are superannuating this year and this was the last IRC.

Institute Management Committee

The 84th Meeting of Institute Management Committee of CMFRI was held 30.08.2018 at CMFRI Hqrs., Kochi. The Director and Chairman, IMC presented a brief about the research achievements made by the Institute. The IMC recommended the proposal for condemnation and disposal of the research vessel Cadalmin IV at Tuticorin RC of CMFRI. The IMC also recommended for acquisition of land from Govt. of Gujarat for the construction of residential quarters and training hostel for CMFRI, Veraval. The IMC recommended the proposal for supply, installation, testing and commissioning of additional 400 KVA, dry type transformer and HT/LT panels at CMFRI Headquarters Building, Kochi and installation of 1 No. additional 400 KVA DG Set at CMFRI Headquarters Building, Kochi.

The 85th Meeting of Institute Management Committee of CMFRI was held 22.12.2018 at CMFRI Hqrs., Kochi. Action taken on the previous meeting held on 19.03.2018 at CMFRI was reviewed. The members of IMC expressed their satisfaction on the research achievements made by CMFRI. The IMC recommended for conversion of students hostel for girls into Training Hostel at CMFRI Residential Complex, Kasturba Nagar, Thevara and for construction of lift (4 passengers) for ATIC Annex Building at CMFRI Headquarters. The IMC also recommended for recognition of Arogya Hospital, Ramanathapuram for medical treatment of staff, family members and Pensioners at Mandapam Regional Centre of CMFRI, Mandapam Camp. The IMC recommended the proposal for procurement of the fluorescence microscope with inbuilt camera suitable software and computer with screen (Fully Automated Upright Research Microscope). The IMC recommended the proposal for hiring private premises for functioning of ICAR-KVK of CMFRI, Lakshadweep.

IJSC Meetings

The 5th and 6th meetings of 13th IJSC of CMFRI were held on 16.04.2018 and 06.07.2018 respectively. The first meeting of the 14th IJSC of CMFRI was held on 29.01.2019.

Human Resource Development cell

Training programs conducted

The institute organized several short-term training programs as well as winter/ summer schools in specialized areas for the scientists. Special training programs were also conducted for the benefit of fishermen, aquaculture farmers, entrepreneurs, professionals, and other stakeholders. Apart from these, Skill Development programmes on 'Marine cage culture and mariculture technologies' and 'Live feed production technologies for marine finfish and shellfish' were

Human Resource Development cell

1. Skill development programme on 'Cage Aquaculture', CMFRI, Kochi

organized with financial support from NFDB, Hyderabad, for 1250 farmers at various locations.

Capacity Building programmes for employees

Capacity building for the various categories of CMFRI employees is undertaken based on Annual training plan (ATP) prepared after assessing the training needs of individual employees. ATP was prepared in such a manner that 20-25% of the employees will be attending on training programmes in a year, i.e., once in 4 years each employee will be attending a training programme to improve his skill and efficiency. During 2018-19, 44 scientists, 58 technical, 31 administrative and 14 skilled supporting staff attended various trainings programmes at CMFRI and other institutes.

Winter school/Short term training

Three winter schools/short-term training were organized during 2018-19.

"Recent advance in Fishery Biology Techniques for biodiversity Evaluation and Conservation", during 01th December to 21st December 2018. (Course director Dr. Rekha J Nair, Pr. Scientist, DFD).

"Climate Change impact and resilience options for Indian Marine Fisheries" during 08th -29th November, 2018. (Course Director: Dr. P U Zacharia, principal Scientist & head DFD).

Short term training on "Application of Advance Molecular Markers in Marine Fishery Recourses Management conservation and sustainable Mariculture"

Training programmes organized by CMFRI during 2018-19

Sl. No.	Subject of Training	Place
1	Applied Microbiological Techniques for fish Health Management	MBTD, CMFRI, Kochi
2	Marine habitats and fisheries	FEMD, CMFRI, Kochi
3	Recent Trends in Mariculture in India"	Karwar RC of CMFRI
4	Brainstorming on seaweed resources and its prospects for culture in Andhra Pradesh	Visakhapatnam RC of CMFRI
5	Open Sea Cage Culture	Karwar RC of CMFRI
6	Fortification of knowledge base on methodologies	Madras RC of CMFRI, Chennai
7	Awareness programme on Conservation of sharks	Mumbai Research Centre of CMFRI
8	Hatchery production and Farming of pompano and cobia	Mandapam RC of CMFRI
9	Hands on training on fish ageing using hard parts	CMFRI, Kochi
10	Crab resources of India and Culture methods	CMFRI, Kochi
11	Marine ornamental fish breeding and culture	CMFRI, Vizhinjam
12	Advances in Marine Fisheries in India'	CMFRI, Kochi
13	Scientific farming practices for sea cage culture	Thoothukudi, Tamil Nadu
14	Cage culture	CMFRI, Kochi
15	Field data collection methodology for the regular and contractual staffs	Puri FC of CMFRI
16	Training programme on GeM	CMFRI, Kochi
17	On Job training on Advances in Mariculture	CMFRI, Kochi
18	Marine ornamental fish breeding and culture	CMFRI, Mandapam of CMFRI

Human Resource Development cell

during 24th October 2018 to 01st November 2018. (Course Director: Dr. Sandhya Sukumaran, Sr, Scientist, MBTD).

International Training Programme

International training programme on Fisheries and Aquaculture was held at CMFRI during 15-28 January, 2019 at CMFRI, Kochi. 13 participants from 11 countries attended the programme sponsored by African-Asian Rural Development Organization, (AARDO), New Delhi, India.

Ph.D. Programmes

Scientists of CMFRI are recognized guides under various reputed universities like Kerala University of Fisheries and Ocean Studies (KUFOS), Cochin University of Science and Technology (CUSAT), Mangalore University, Mahatma Gandhi University, Andhra University, Madras University, Kerala University. Presently, 73 scholars are pursuing their doctoral degree programmes at CMFRI, Kochi and its centres under various universities.

M.Sc. dissertation programme

Opportunities were given to final M.Sc. students to do their project work at various divisions of CMFRI. An Online application portal is developed and students can apply for the 3 months programmes on various subjects listed. Selection of the students is based on the availability of guides and a set of criteria for each branch of study.

1. Training on 'GeM-for the procurement of Goods and Services', CMFRI, Koch

Women Cell Activities

The women's cell of CMFRI organised a talk by Dr.Sulochana Nalappat as part of the International women's day celebration on 8th March, 2019. Dr.A .Gopalakrishnan, Director, CMFRI and Dr.Somy Kuriakose, Chairperson, Women cell also spoke on the occasion.

The women cell of CMFRI initiated regular Zumba and Yoga classes at CMFRI, Kochi with the aim of improving the overall mental and physical wellbeing of the women staff to accomplish better performance and efficiency at professional and personal spheres.

1. A section of the audience
2. Dr.Sulochana Nalappat addressing the staff

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Major Events

1. Hon. Chief Minister of Kerala Shri Pinarayi Vijayan, inaugurates Southern Fisheries Ministers Conference, 10-11 November, 2018 at ICAR- CMFRI.
2. Inauguration of AARDO International Training Programme, 15-28 January 2019
3. LENFEST International Workshop 24-28 September 2018
4. AINP Mariculture Annual Review Meeting, 27-28 July 2108
5. MoU signing with Kerala State Fisheries Department on 18 July 2018
6. Minister of State for Agriculture Fisheries and Farmers Welfare at CMFRI on 29 May 2018
7. Valedictory function of Platinum Jubilee Celeberations on 21 July 2018
8. Interaction with a high level delegation from Hawassa University, Ethiopia from 28 May to 1 June 2018
9. MSC International Workshop on 5 April 2018
10. Press meet and data release on 26 June 2018

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Major Events


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Marine Biodiversity Museum

Museum Depositions during 2018

A total of 57 specimens were deposited in the museum during the year. This includes 18 species of fishes, 5 species of crustacean, 22 species of molluscs, 7 species of cnidarians, 3 species of seaweeds and 2 species under miscellaneous. Out of which 4 specimens were holotypes. Accession numbers were allotted to all the depositions. The holotype were Conus sp. nov. (DB. 35.1.26) , Filisoma argusi, a nematode parasite (male and female) (HA.1.1.2.4) , Octopoteuthis n sp. (DF.2.5.2.1.1) and Eumunida multispina n.sp (ED.4.4.1.5).

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Marine Biodiversity Museum

1. School children visiting biodiversity museum on the foundation day

New Specimen added to Museum Collection

Sl.No.	FISHES	Acc. No.
1	*Oncorhynchus gorbuscha* (Walbaum,1792)	GB.45.5.1.1
2	*Aetobatus flagellum* (Bloch & Schneider ,1801)	GA.7.4.2.5
3	*Scorpaenopsis neglecta* Heckel,1837	GB.38.24.40.6
4	*Istiophorus platypterus* (Shaw ,1792)	GB.32.4.2.4
5	*Epinephelus faveatus* (Valenciennes,1828)	GB.31.139.22.90
6	*Otolithoides biauritus* (Cartor ,1849)	GB.31.134.28.1.1
7	*Takifugu oblongus* (Bloch ,1786)	GB.43.6.24.9.1
8	*Carassius auratus* (Linnaeus ,1758)	GB.22.2.2.5
9	*Carassius auratus* (Linnaeus ,1758)	GB.22.2.2.5.1
10	*Epinephelus bleekeri* (Vaillant,1878)	GB.31.139.22.12.1
11	*Epinephelus diacanthus* (Valenciennes, 1828)	GB.31.139.22.28.1
12	*Epinephelus coioides* (Hamilton, 1822)	GB.31.139.22.28.1
13	*Epinephelus longispinis* (Kner, 1864)	GB.31.139..22.54.1
14	*Ostracion cubicus* Linnaeus, 1758	GB.43.5.9.1.1
15	*Polypnus indicus Schultz,1961*	GB.42.1.1.1
16	*Macrorhamphosodes platycheilus* Fowler ,1934	GB.43.8.10.5
17	*Ostorhinchus fleurieu* Lacepède, 1802	GB.31.9.5.10
18	*Polymixia japonica* Gunther,1877	GB.34.1.1.6
CRUSTACEANS		
19	*Pasiphaea alcocki* - Wood - Mason & Alcock,1891	ED.8.4.3.1
20	*Euphausia superba*	EC.1.1.1.1.1
21	*Glyphocrangon investigatoris* Wood-Mason&Alcock,1891	ED.2.8.1.1.1
22	*Eumunida multispina n.sp.*	ED.4.4.1.5
23	*Eumunida multispina n.sp.*	ED.4.4.1.5.1
MOLLUSCANS		
24	*Tremoctopus gracilis*	DE.2.1.1.1
25	*Murex virgineus* (Roding ,1798)	DB.22.7.5.1
26	*Cantharus tranquebaricus* (Gmelin,1791)	DB.24.2.1.1
27	*Erronea errones* (Linnaeus ,1758)	DB.15.5.1.1
28	*Diodora ticaonica* (Reeve ,1850)	DB.21.1.5
29	*Gafrarium divaricatum* (Gmelin ,1791)	DC.17.2.9.1
30	*Gafrarium divaricatum* (Gmelin ,1791)	DC.17.2.9.2
31	*Chama* sp.	DB.9.4.1.1
32	*Lophiotoma* sp.	DB.3.4.3.5
33	*Conus*.sp.nov.	DB.35.1.26
34	*Ommastrephes bartramii* (Lesueur, 1821)	DE.2.1.5.4.1
35	*Ommastrephes bartramii* (Lesueur, 1821)	DE.2.1.5.4.2
36	*Ommastrephes bartramii* (Lesueur, 1821)	DE.2.1.5.4.3

Marine Biodiversity Museum

1. AARDO trainees in the museum

37	*Ommastrephes bartramii* (Lesueur, 1821)	DE.2.1.5.4.3
38	*Ommastrephes bartramii* (Lesueur, 1821)	DE.2.1.5.4.4
39	*Ommastrephes bartramii* (Lesueur , 1821)	DE.2.1.5.4.5
40	*Thaumoctopuus mimicus* (Norman and Hochberg , 2005)	DE.3.1.2.8
41	*Sthethnoteuthis oulaniensis*	DE.2.3.1.1.1
42	*Hexabranchus sanguineus* (Ruppell & Leuckart, 1828)	DJ.31.1.1
43	*Nerita undata* Linnaeus , 1758	DB.5.1.8
44	*Lyncina propinqua* (Garrett, 1879)	DB.15.2.8
45	*Octopoteuthis* n sp.	DF.2.5.2.1.1

CNIDARIANS

46	*Pelagia noctiluca* (Forsskal, 1775)	CA.9
47	*Ellispomyxa ariusi*	CG.3.1.1.1
48	*Ellispomyxa ariusi*	CG.3.1.1.1.1
49	*Ortholinea argusi*	CG.3.2.1.2
50	*Ortholinea argusi*	CG.3.2.1.2.1
51	*Acropora cf. austera*	CF.1.1.1.40
52	*Acromitus flagellatus* (Haeckel)	CA.3

SEAWEEDS

53	*Ecklonia radiata* J. Agardh,1848	AB.4.1.1.2
54	*Macrocystis pyrifera* (giant kelp)	AB.4.1.1.1
55	*Kandelia candel*	MB.1.1.1.1

MISCELLANEOUS

56	*Lepidochelys olivacea*	Misc.52
57	*Filisoma argusi* n.sp.	HA.1.1.2.4

Marine Biodiversity Museum

Visitors to the Museum

Months	No. of Schools	No. of students	No. of colleges	No. of students	Public	Total
April	2	111	7	207	384	702
May	2	50	4	122	454	626
June	0	0	1	15	151	166
July	1	13	5	209	65	287
August	2	210	2	120	59	389
September	5	142	5	21	110	273
October	8	269	6	269	93	631
November	19	1446	4	119	450	2015
December	10	659	9	358	373	1390
January	10	591	15	601	254	1446
February	46	3053	36	3600	663	7316
March	12	871	9	387	224	1482
Total						16723

VIP Visitors to the Museum

Sl. No.	Name
1	Mr. R.Mounissamy, Director of Fisheries, Govt. of Puducherry
2	Mr. J. Nadarajan, Dy. Director of Fisheries, Govt. of Puducherry
3	Miss. Priscilla Cooper, R&D Officer , Ministry of Defence, Mauritius
4	Dr. Manoj Nardeosingh, Asst. Secretary General AARDO, New Delhi
5	Mr. K.S. Srinivas, IAS, Chairman MPEDA
6	Dr. Anupama Ambika, Scientific Coordinator French Embassy
7	Dr. J. Himendranath, IPS, Commissioner of Police , Thrissur

Krishi Vigyan Kendra

Commenced 'Farm Shoppe'

'Farm shoppe-the safe food store' was commenced at the CMFRI, Kochi on 4th January, 2019. The Shoppe was inaugurated by Dr. A .Gopalakrishnan, Director, CMFRI, Kochi. This is an initiative to provide market avenue for farmers in line with the *Doubling Farmers' income by 2022* programme of Government of India. Farm Shoppe is a model that ensures fair price to farmers while supplying safe food to the consumers.

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1. Dr. A. Gopalakrishnan, Director, CMFRI inaugurating the Farm Shoppe
2. Dr. P. Muralidharan leading the talk as part of District Coconut Seminar at Naryarambalam
3. Live webcast of Hon'ble Prime Minister's interaction with women SHG members
4. Flood relief camps in association with experts from ICAR-CCARI, North Goa

Conducted Karshika Mela

KVK conducted District Karshika Mela in collaboration with ATMA, Ernakulam during 15th to 16th February 2019.An Agro machinery expo and District Coconut Seminar was also part of the mela. Approximate**ly 1500 fa**rmers an**d 150 o**fficials participated.

Live webcast of Hon'ble Prime minister's programmes

Hon'ble Prime Minister Shri. Narendra Modi's interaction with farmers and SHG members of the country held on 20th June 2018 and another interaction with women SHG members held on 12thJuly 2018 were webcasted live at CMFRI Kochi for the benefit of local farmers and officials. The inaugural function of Pradhan Mantri Kisan Samman Nidhi (PM-Kisan) was also webcasted on 24th February 2019.

Farmer producer company inaugurated

The Periyar valley spices farmer producer company limited, promoted and nurtured by the KVK with funding of NABARD commenced its formal operation on 13th August 2018 at Kothamangalam. Shri. Antony John M.L.A inaugurated and Dr. M. J. Chandregowda, Director, ATARI, Bengaluru distributed share certificates.

Flood relief programmes.

KVK participated in flood relief programmes at various places in the district to advise immediate protective measures to the surviving crops, revival strategies to fish farmers and conducted animal health camps along with a team of expert Scientists from ICAR- CCARI, North Goa and veterinary experts of State

Sustainable management of fishery resources: Growout technologies

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1. Trainees of EDP on pearl spot seed production
2. Activities as part of `Swachtha Hi Sewa'
3. Curry leaf kit distribution to school children by Governor Shi. P. Sathasivam
4. Participants of ASCI – Aquaculture worker short course
5. Participants of ASCI – Nursery worker short course
6. Participants of the training programme conducted by KVK, Ernakulam

animal husbandry department. Analysis of deposited soil conducted. Post flood recommendation in agriculture, animal husbandry and fisheries released.

Responsible fish vending

KVK is promoting Responsible fish vending through trainings. This programme ensures fish delivered to consumers are safe-to-eat and the markets are clean and healthy. One of such markets named *Visha vimukta malsya vipani* is functioning at Vypin.

Conducted EDP on Pearl spot seed production

Subsequent to the success of producing Pearlspot seeds in a PPP mode with farmers in KVK's Satellite Production Centres (SPCs), an entrepreneurship development programme was conducted for 74 selected farmers during 31stJuly to 2ndAugust 2018 at CMFRI with funding support of NFDB, Hyderabad.

Swachhta Hi seva and Swachhta pakhwada campaign

Swachhta Hi Seva campaign was conducted during the period 15th September to 2nd October 2018 and Swachhta pakhwada during December 15th to December 31st 2018.

Celebrated World soil day

Celebrated World soil day on 5th December, 2018 at CMFRI. Dr. Manoj P Samuel, Head, Engineering division, CIFT delivered a lecture which was followed by a farmer-scientist interface.

Curry leaf kits distributed to school children

KVK supplied kits containing curry leaf saplings, dolomite and leaflet on how to grow curryleaf to 5000 school children in Ernakulam. The programme was funded by Prof K.V. Thomas Vidhyadhanam trust. The programme was inaugurated by Hon'ble Kerala governor Justice Shri. P. Sathashivam on 22nd January, 2019 at Santa cruz HSS school, Fort Kochi.

Short courses

Conducted two 25 days short courses of ASCI one on *Aquaculture Worker* (26thNovember to 20thDecember 2018) and another on *Nursery worker* (15th January to 12th February, 2019). The courses were part PMKVY.

Trainers training programme conducted

Conductedtrainers training programme on Cage Fish Farming exclusively for the technicians of Kerala KVKs during 26th to 27th October 2018 at ICAR CMFRI, Kochi.

Official Language Implementation Activities

Awards and Recognitions

Rajarshi Tandon Award

CMFRI bagged Rajarshi Tandon Award for the 9th time introduced by ICAR for the Excellent Official Language activities among the Institutes situated in 'C' Region for the year 2016-2017. The Award was distributed during the 90th Foundation Day of ICAR organized in NASC Complex, New Delhi on 16.07.2018. Dr. A. Gopalakrishnan, Director, CMFRI and Shri Navin Kumar Yadav, Assistant Director (OL) received the Award from

Official Language Implementation Activities

Hon'ble Minister for Agriculture and Farmers' Welfare Shri Radha Mohan Singh. Shri Gajendra Singh Shekhavat, and Shri Parshotam Rupala, Hon'ble State Ministers for Agriculture and Farmers' Welfare and Dr. Trilochan Mohapatra, Secretary, DARE & Director General, ICAR were also present on the occasion.

Rajbhasha Gaurav Puraskar

Dr. A. Gopalakrishnan, Director, ICAR-Central Marine Fisheries Research Institute, Kochi and Dr. Imelda Joseph, Principal Scientist and Head In Charge, Mariculture Division bagged prestigious *Rajbasha Gaurav Puraskar* 2017-2018 for Non- Hindi Speaking Region for their Hindi article 'Mariculture technologies for doubling of income of fishermen' published in CMFRI In House Hindi Magazine 'Matsyagandha'. Dr. Imelda and Dr. A. Gopalakrishnan received the Award from Shri M. Venkaiah Naidu, Hon'ble Vice President of India during Hindi Day programme organized at Vigyagn Bhavan, New Delhi on 14th September, 2018. Shri Rajnath Singh, Hon'ble Home Minister, Shri Hansraj Gangaram Ahir, Hon'ble Minister of State for Home Affairs, Shri Kiren Rijiju, Hon'ble Minister of State for Home Affairs were also present on the occasion.

Town Official Language Implementation Committee Rolling Trophies for CMFRI

Central Marine Fisheries Research Institute, Cochin bagged *Rajbhasha*

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1. Director and Hindi officials' receiving the Rajarshi Tandon Award for the 9th time introduced by ICAR for the Excellent Official Language activities among the Institutes situated in 'C' Region for the year 2016-2017.
2. Director and Head I/c Mariculture CMFRI receiving the *Rajbasha Gaurav Puraskar* 2017-2018 for non- Hindi Speaking Region for their Hindi article 'Mariculture technologies for doubling of income of fishermen' published in CMFRI In-house Hindi Magazine '*Matsyagandha*'

Official Language Implementation Activities


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Rolling Trophy (Ist Position) of Kochi Town Official Language Implementation Committee for the best implementation of Official Language during 2017-18. Award was distributed in the meeting held at Income Tax Office, Cochin on 15.03.2019 by Shri N. Jayasankar, IRS, Commisioner of Income Tax, Kochi and Dr. K. Ajitha, Head, Department of Hindi, CUSAT, Cochin.

Our Institute bagged Rolling Trophy (Ist Position) for Best Hindi House Magazine *Matsyagandha* (2017-18).

Extension activities

Hindi Day / Week Celebration

Hindi Day was observed at CMFRI Headquarters, Cochin on 14th September, 2018. Messages on Hindi Day issued by Hon'ble Home Minister Shri Rajnath Singh, Hon'ble Agriculture and Farmers' Welfare Minister Shri Radha Mohan Singh and Secretary, DARE & Director General of ICAR Dr. Trilochan Mohapatra were circulated among staff members.

Special incentive scheme: Cash incentives were presented to 6 staff members at Headquarters under CMFRI special incentive scheme for doing original work in Hindi during the year 2017-18.

Mandapam Regional Centre

Hindi Week 2018 was celebrated at Mandapam Regional Centre of CMFRI during 14th to 24th September, 2018 with various competitions such as Hindi Transliteration, Translation, Essay writing, Noting and Drafting, Technical Terminology. Ms. S. Sumathi, Principal, Kendriya Vidyalaya inaugurated the celebration on 14th September, 2018 by lighting the lamp. The valedictory function was held on 24th September, 2018 in which the Chief Guest Dr. Murali, Associate Professor, Department of Hindi, Madura College, Madurai inspired staff members to implement Official Language

Official Language Implementation Activities

1. Dr. G. Maheswarudu and Official Language Team receiving the Rolling Trophy
2. Cash incentives to CMFRI staff for doing original work in Hindi
3. A view of Hindi workshop at Headquarters, Kochi

and promote mother tongue also. He distributed the prizes to the winners of competitions, cash awards to winners of Hindi course Praveen and Pragya and cash incentives under Hindi incentive scheme for writing original noting and drafting in Hindi.

Participation in Joint Official Language Celebration – 2018: Officers and staff of the Institute participated and won prizes in various competitions of Kochi Town Official Language Implementation Committee Joint Official Language celebration-2018 held at Income Tax Office, Cochin. Hindi Song and Hindi Typing Competitions were conducted at CMFRI, Cochin.

Hindi workshops

In order to motivate staff members to do their work in Hindi and to increase the use of Official Language in day to day work Hindi workshops were conducted and total 587 Officers and staff members were trained at Headquarters, Cochin as well as Outstations during the period as follows.

Headquarters, Kochi 20.06.2018, 15.09.2018, 17.12.2018 and 06.03.2019.
Hindi workshop at Mandapam RC 12.06.2018, 10.09.2018, 05.12.2018 & 19.03.2019
Hindi workshop at Veraval RC 22.09.2018
Hindi workshop at Madras RC 21.04.2018 & 14.09.2018
Hindi workshop at Tuticorin RC 30.06.2018, 27.09.2018 & 21.12.2018
Hindi workshop at Mangalore RC 18.09. 2018 & 21.12.2018
Hindi workshop at Mumbai RC 29.09.2018 & 31.10.2018
Hindi workshop at Karwar RC 30.06.2018, 29.09.2018, 26.12.2018 & 17.03.2018

Article Publication

Article on 'Mariculture technologies for enhancing the income of fish farmers' written by Dr. Imelda Joseph., Head In Charge, Mariculture Division was published in the December, 2018 issue of ICAR Hindi Magazine *Kheti.*

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Official Language Implementation Activities

Meetings / Trainings

Quarterly meetings of Official Language Implementation Committee

During the year 2 meetings of the Official Language Implementation Committee of the Institute were conducted on 20.07.2018 and 21.12.2018.

Half yearly meeting of Town Official Language Implementation Committee

Attended meetings of Town Official Language Implementation Committee at Income Tax Office, Cochin on 19.06.2018 and 26.03.2019.

Participation in Conference / Training

Assistant Director (OL) and ACTO (Hindi) attended Two days National Seminar on 'New dimensions in Official Language Policy in ICAR' conducted at ICAR-CRIDA, Hyderabad on 24 & 25.04.2018.

Assistant Director (OL), ACTO (Hindi Translator) and Technical Assistant (Hindi Translator) attended One day National Seminar on 'Progressive use of Official Language' conducted at ICAR-CIFT, Cochin on 23.07.2018.

ACTO (Hindi Translator) and Technical Assistant (Hindi Translator) attended One day Official Language Seminar conducted by Central Govt. TOLIC as well as PSU TOLIC under the auspices of Hindustan Petroleum Corporation Ltd., Cochin on 06.01.2019. Dr. Shyam S.Salim, Principal Scientist, SEETTD gave a Power Point Presentation on Official Language activities of CMFRI in Hindi.

Technical Assistant (Hindi Translator) attended 2 days Hindi Seminar conducted by Sree Sankaracharya Sanskrit University, Kalady on 30-31 January, 2019.

Assistant Director (OL) and Technical Assistant (Hindi Translator) attended Official Language Regional Conference conducted at CUSAT, Cochin on 14.02.2019.

Assistant Director (OL)) attended Two days Official Language Seminar on 'Use of Official Language in Scientific Research Institutes' conducted at ICAR-CIFE, Mumbai on 25 & 26.02.2019.

Dr.J.Jayasankar, Principal Scientist, FRAD and Dr. Biji Xavier, Scientist, Visakhapatnam Regional Centre attended Scientific Hindi Seminar conducted by ICAR-CIFE Kakinada Regional Centre on 'New Dimensions of Mariculture in Southern States of India' on 15th March, 2019.

Inspections

Parliamentary Committee inspections

The Second Sub-Committee of the Committee of Parliament on Official Language inspected the Official Language activities of Visakhapatnam Regional Centre of ICAR-Central Marine Fisheries Research Institute, Cochin on 08.09.2018.

The inspection committee comprised of Dr. Prasanna Kumar Patsani, MP (Lok Sabha), Convener, Dr. Sunil Baliram Gaikwad, MP (Lok Sabha), Shri Pradeep Tamta, MP (Rajya Sabha), Shri Sushil Kumar Gupta, MP (Rajya Sabha), Dr. Sathyendra Singh, Senior Research Officer, Shri Vikas Varma, Hindi Officer, Shri Abdul Moheeb, Assistant & Shri Viney Kumar, Stenographer.

Dr. A. Gopalakrishnan, Director, Shri C. Muralidharan, Chief Administrative Officer, ICAR-CMFRI, Kochi, Smt. Seema Chopra, Director (OL) & Dr. Prem Kumar, Principal Scientist, ICAR, New Delhi, Dr. Shubhadeep Ghosh, Scientist in Charge, Dr. Indira Divipala, Scientist, Visakhapatnam Regional Centre, Shri Navin Kumar Yadav, Assistant Director (OL), Smt E.K.Uma, Asst.Chief.Tech.Officer (Hindi), ICAR-CMFRI, Kochi & Shri Manoj Kumar, Asst. Chief Tech. Officer, ICAR, New Delhi attended the inspection meeting. The Official Language implementation

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Official Language Implementation Activities

1. Dr.J.Jayasankar, Principal Scientist, FRAD, making a presentation at a Scientific Hindi Seminar conducted by ICAR-CIFE Kakinada
2. Director and staff with Second Sub-Committee of the Committee of Parliament on Official Language at Vishakhapatnam

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activities of ICAR-CMFRI were reported to the committee during the inspection.

The Committee expressed satisfaction and happiness in implementation of Official Language activities in the Visakhapatnam Regional Centre. Hindi Books and Publications / Awards, Shields and Trophies were exhibited.

Inspection by ICAR

Dr. P. Pravin, Assistant Director General (Marine Fisheries), ICAR inspected the Official Language activities of Veraval Regional Centre of CMFRI on 08.06.2018.

Inspection by Department of Official Language

Shri Tech Chand, Deputy Director (Impl.), Regional Implementation Office, D/o Official Language, Bangalore inspected the Official Language implementation activities of Karwar Research Centre of CMFRI on 14.06.2018.

Official Language inspections at Outstations

Director, CMFRI inspected the OL implementation activities of Mandapam RC of CMFRI on 30.06.2018.

Review of Official Language implementation activities of Outstations and guidance

The Official Language implementation activities of all Regional and Research Centres were reviewed in Special focus to complete obligatory Training in Regional / Research Centres in Tamil Nadu

Scientists, Technical and Administrative staff of Mandapam Regional Centre of CMFRI are trained by the Institutional arrangements in Hindi Prabodh, Praveen and Pragya courses.

A word a Day: Under A word a day programme around 282 Hindi words with English equivalents were displayed on Electronic display board and circulated among staff members of Headquarters and Outstations.

Bilingualisation and targets of correspondence

During the period all the documents (640) under Section 3(3) of Official Language Act 1963 were issued in bilingual. Out of 755 letters received in Hindi 726 were replied to in Hindi. Percentage of Hindi correspondence during the year was 58.4% against the target of 55%.

Under bilingualization programme during the period 18 name plates, 14 Rubber stamps, 37 Identity cards of staff members, Certificates of Headquarters and KVK training programmes, Banners of various programmes, Project Headings of Outstations were prepared bilingually.

Institute Publication in Hindi

CMFRI Newsletter *Cadalmin* Hindi– Issue Nos. 154, 155, 156 & 157.

Swachh Pakhwada initiatives in ICAR-CMFRI

It has become a social empowerment vision with the aim of creating clean India. The Mission is not just about cleaning surroundings but also about seeking people's participation in making the environment waste free and providing sanitation facilities, paving a way for *Swachh Bharat*. ICAR-CMFRI is striving hard for the accomplishment of the mantra of '*Na gandagi karenge, Na karne denge*'given by our Honourable Prime Minister Shri Narendra Modi.

ICAR-CMFRI showcased the need for clean India through its various programmes

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Swachh Pakhwada

1. Swachh Bharath pledge at Cochin
2. Cleaning of Vishakhapatnam Harbour Road
3. KVK - Cleaning of Narakkal beach as part of Swachhta Pakhwada activities
4. Swachh Bharat activity at our Calicut RC
5. Swachh Bharat activity at our Karwar RC

which includes cleanliness drives across the public utility avenues, developing technologies aimed at waste reduction, imparting awareness and reaching out of public through media and involvement of children and youth and by inviting inspiring change agents and showcasing changes manifested from civic societies.

During the period several thematic drives and special campaigns were introduced and implemented at the community level bringing in a positive shift in communities behaviour and building positive mindsets towards the municipal / sanitation services. Increased knowledge and awareness regarding waste and environment have made the people conscious about their environment, health and sanitation. Nearly 80% of official works has been digitized and official communication to the staff and other institutions etc. has been done either through email and whatsApp messages as parts of e-office to avert paper utilization and protect the environment and nature, Basic maintenance is done where regular cleaning of work places, hatcheries, laboratories and toilets are effectively performed. Installation and maintenance of solar light and LED lights for minimal power consumption is implemented. Collection and careful disposal of plastic pieces, laboratory chemical and glass wastes is in practice. The major highlight during this period was the new initiative

Swachh Pakhwada

1. Swachh Bharat activity at our Mandapam RC
2. Swachh Bharath activity at our Veraval RC in association withCoast Guard
3. Swachh Bharath activity in front of CMFRI

for laboratory waste management by setting up a glass crushing unit (designed by Mr. Anoop Augustin of the Estate and Maintenance Cell of ICAR-CMFRI) that will manage the recycling of refused glass bottles used in laboratories by pulverizing them into the sand-like granules, which could be used for construction works. Besides laboratory glass bottles, all refuse glass materials, including tube lights, could be recycled in the same way using this facility. Construction of toilet facility at Mandapam fish landing centre was undertaken under the sanitation and solid waste management (SWM). Go Green initiatives were implemented with a plastic free zone maintenance and cleaning and beautification of surrounding areas. Eradication of '*seemai karuvelam*' (*Prosopis juliflora*) within the premises of Mandapam Regional Centre was done. The importance of cleanliness of mind, body and environment was stressed and relative talks were conducted. Mumbai RC of ICAR-CMFRI participated in a beach awareness campaign on plastic litter as a part of #End Plastic pollution initiatives organized by Earth Day Network (Global Environment NGO) at Juhu beach. Awareness regarding disposal of stranded marine mammals at Juhutara beach after beaching of stranded cetaceans was created among the stakeholders including tourists, officials from forest, State Fisheries department and Greater Mumbai Municipal Corporation. Conservation of Marine Life was promoted through a competition aimed to involve and educate students in the regarding waste management from an early age. *Swachhta Hi Sewa* 2018 (SHS) campaign was observed during 15th September to 2nd October 2018 by all centers of ICAR-CMFRI. Litter status of Indian beaches was given in CMFRI Infographics page.

CMFRI Headquarters and its different regional,research and field centers continue to strive for full filling the vision of Mahatma Gandhi in his 150th birth centenary celebrations.

Publications

Peer Reviewed Articles

Adnan Gora, Vidhya Jayasankar, Saima Rehman, Joe K. Kizhakudan, Laxmilatha, P. and Vijayagopal, P. 2018. Biochemical responses of juvenile *Panulirus homarus* under different feeding regimes. *J. Appl. Anim. Res.,* 46(1): 1462-1468.

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Saravanan, R. 2018. *Marine Pollution–Stop Polluting the Sea*. CMFRI Poster No. 44/2018.

Leaflets

Shelton Padua 2018. *Plastic waste management Why and How?*

Mohammed Koya, K.,Vipin Kumar, V. P., Ramachandran, C., Binsi, P. K. and Sreelatha, P. 2019. *Wealth from fish waste–A KVK Lakshadweep Intervention on Entrepreneurial Capacity Building*.

Pralaya Ranjan Behera, Jishnudev, M. A., Shubhadeep Ghosh, Loveson Edward, L., UmaMahesh, V., Prabhakar, R. V. D.,, Saravanan, R. and Joshi, K. K. 2018. *Jellyfish diversity and distribution along the coast of Andhra Pradesh–First aid measures of Jellyfish stings*. CMFRI Pamphlet No. 61/2018.

Ramachandran, C., Reshma Gills, Ignatious B. Mandro and Sandhia, R. 2018. *Kerala Fishing Regulation Act*.

Ritesh Ranjan, Sekar Megarajan, Biji Xavier, Shubhadeep Ghosh and Chinni, B 2018. *Seed production and culture of orange spotted grouper Epinephelus coioides*.

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Ritesh Ranjan, Sekar Megarajan, Biji Xavier, Shubhadeep Ghosh and Vamsi, B 2018. *Low cost recirculating aquaculture system for marine finfish broodstock development*.

Santhosh, B., Anil, M. K., Muhammed Anzeer, F. and Aneesh, K. S., Abraham Mijo, V., Gopakumar, G., Rani Mary George, Gopalakrishnan, A. and Unnikrishnan, C. 2018. *Culture techniques of marine copepods*. CMFRI Booklet Series No. 4/2018.

Saravanan, R., Ranjith, L., Laxmilatha, P., Abdul Nazar, A. K., Joshi, K. K. and Sadiq, I. Syed 2018, Jellyfish of Gulf of Mannar and Palk Bay

Shyam S. Salim, Navin Kumar Yadav, Vandana, V. and Manjusha, U. 2018. *Know your warming planet–ClimEd Series:1B*

Shyam S. Salim, Navin Kumar Yadav, Vandana, V., Bindhu Antony, Manjusha, U. and Niveditha, S. 2018. *Learning and coping climate change–ClimEd Series: 2B*

Shyam S. Salim, Vipinkumar, V. P., Athira, N. R. and Ann Mary Jephi 2018. *Societal role in curbing climate change–ClimEd Series: 3C*

Shyam S. Salim, Salini, K. P., Reeja Fernandez and Harshan, N. K. 2018. *Climate change and policy–ClimEd Series: 4C*

Shyam S. Salim and Athira, P. R. 2018. *Role of households in combating climate change–ClimEd Series:5C*.

Videos

Abdul Nazar, A. K., Jayakumar, R., Johnson, B. and Anikuttan, K. K. 2019. *Marine ornamental fish production–An alternate livelihood for coastal people*. CMFRI Video No. 30/2019.

Vipinkumar, V. P., Harshan, N. K., Vidya, R., Narayanakumar, R., Athira, P. V., Jeethumol, T. J., Ann Mary Jephi and Gopalakrishnan, A. 2018. *Seafood kitchen – Successful women empowerment*.

Participations

Conferences/Meetings/Workshops/Symposia/Trainings/Deputation

Dr. A. Gopalakrishnan, Director

Senior Executive Development Programme on "Effective Organizational Leadership" for Senior Officers of ICAR, jointly organized by ASCI and ICAR-NAARM, Hyderabad, 09 -13 April 2018

Pre-thesis submission colloquium of two Ph. D. students, as Supervising Guide, Department of Biosciences, Mangalore University, Mangaluru, 27 April 2018

Brainstorming session to discuss and evolve a plan of action for skilling fisheries sector in convergence with the activities of all the Fisheries Institutions under the ICAR and the DADF, NFDB, Hyderabad, 02 May 2018

Meeting on Mariculture Policy under the chairmanship of Chief Executive NFDB, Hyderabad, 15 May 2018

Third International Symposium on Fisheries Education for a Sustainable Blue Economy, ICAR-CIFE, Mumbai, 16 May 2018

National Conference of Fisheries Ministers of Coastal States/UTs held under the chairmanship of Hon'ble Union Ministers for Agriculture & Farmers Welfare, Krishi Bhavan, New Delhi, 17 May 2018

DBT Task Force meeting and Review of works carried out at ICAR-CMFRI under the Outreach Activity on Fish Genetic Stocks and the Antimicrobial Resistance Network Project, ICAR-NBFGR, Lucknow, 12–13 June 2018

Meeting to discuss the issue relating to Revision/ Framing of Recruitment Rules for Fishing Vessel Crew for Fisheries Research Institutes of ICAR under the chairmanship of the Special Secretary, DARE & Secretary, ICAR, New Delhi, 19 June 2018

Review of research and other activities of Vizhinjam Research Centre of ICAR-CMFRI, Vizhinjam, 23 June 2018

90th Foundation Day of ICAR and Award ceremony, NASC Complex, Pusa, New Delhi, 16 July 2018

Cadre Review meeting chaired by DG, ICAR along with Secretary, ICAR, Deputy Director General (FS) and Director (P), NASC Complex, Pusa, New Delhi, 16 July 2018

Meeting under the Chairmanship of Secretary, DARE & DG, ICAR to share the experiences of participants of "Senior Executive Development Programme (SEDP) on "Developing Effective Organizational Leadership for Senior Officers of ICAR" jointly organized by ASCI and ICAR-NAARM, Krishi Bhavan, New Delhi, 23 July 2018

Write shop-cum-training programme on "Tropical Marine Finfish Seed Production and Farming Technologies", Visakhapatnam RC of ICAR-CMFRI, 14 August 2018

Flag hoisting ceremony of 72nd Independence Day, Visakhapatnam Regional Centre of ICAR-CMFRI, 15 August 2018

Inspection of Parliamentary Committee on Official Language, Visakhapatnam Regional Centre of ICAR-CMFRI, 08 September 2018

Meeting on 'Blue Economy Working Group 3 (Fisheries, Aquaculture and Fish Processing), NITI Aayog Bhawan, New Delhi, 08 October 2018

ASRB-CAS meeting, ASRB, New Delhi, 29–30 October 2018

Meeting with the Chairman, Working Group-III, EAC to the Prime Minister to discuss on the preparation of draft Report on Blue Economy: Fisheries, Aquaculture & Fish Processing, New Delhi, 28–29 November 2018

Pre-thesis submission colloquium of Ph. D. student, as Supervising Guide, Department of Biosciences, Mangalore University, Mangaluru, 04 December 2018

NFDB Project Review meeting with the Chief Executive, NFDB at Vizhinjam Research Centre of ICAR-CMFRI, Vizhinjam, 08–09 December 2018

Meeting with DG, ICAR and DDG (FS), to discuss on the amalgamation of Mumbai Research Centre of ICAR-CMFRI, New Delhi, 11–12 December 2018

Meeting with the Hon'ble Union Agriculture Minister along with Dr. A. K. Abdul Nazar, Principal Scientist, ICAR-CMFRI and Mr. K. Muraleedharan, IMC Member, ICAR-CMFRI regarding the proposed village adoption programme, Rameshwaram, New Delhi, 16–17 January 2019

World Brackishwater Aquaculture Conference (BRAQCON 2019), ICAR-CIBA, Chennai, 22–23 January 2019,

Annual Conference of Vice Chancellors of Agricultural Universities & Directors of ICAR Institutes, NASC Complex, Pusa, New Delhi, 31 January–01 February 2019

Meeting of the Directors of Fisheries Research Institutes of ICAR, NASC Complex, Pusa, New Delhi, 02 February 2019

14th Agricultural Science Congress organized by NAAS, ICAR and IARI, NASC Complex, New Delhi, 20–23 February 2019

Abdul Azeez, P. Stakeholder meeting on Lakshadweep Livebait Fisheries Management Plan. Kavaratti, Lakshadweep, 23 January 2019

Ajay D. Nakhawa and Santosh N. Bhendekar TC Oocean-INCOIS training course on "Fish-catch Time-Series Forecasting with R". INCOIS, Hyderabad, 24-28 September 2018

Ajay D. Nakhawa and Thirumalaiselvan, M. Winter School on "Climate change impacts and resilience options for Indian marine fisheries". ICAR-CMFRI, Kochi, 08-29 November 2018

Akhilesh, K. V., Ajay D. Nakhawa and Nilesh A. Pawar Meeting on ONGC seismic survey impact on fisheries, Mumbai, 12 February 2019

Anikuttan, K. K., Johnson, B., Ranjith, L. and Sakthivel, M. Meeting of the Core Team on ¨Preparation of the Guidelines for Green Certification of marine ornamentals", ICAR-CMFRI, Kochi, 02–03 August 2018

Anulekshmi Chellappan Meeting of Maharashtra Coastal Zone Management Authority (MCZMA). Mumbai, 2 November 2018; 20 December 2018; 24 April 2019

Delivered speech for one-day National Symposium on "Ocean Medicine Present and Future" University of Mumbai, 15 December 2018

BLUCON 2019 Conference, Navi Mumbai, 28 February 2019

Women's Day Celebration Organised by Sagar shakthi. Marol, Mumbai, 08 March 2019

Anulekshmi Chellappan and Nilesh Pawar Discussion with Law and Judiciary Department and State fisheries officials, Govt. of Maharashtra regarding the implementation of Turtle Excluder Device in trawl net, Mantralaya, Mumbai, 26 April 2019

Anulekshmi Chellappan, Ramkumar, S., Akhilesh, K. V., Santosh N. Bhendekar, Ajay D. Nakhawa and Ratheesh Kumar, R. Workshop on History of trawl fishery in Maharashtra. Mumbai RC of ICAR-CMFRI, Mumbai, 26 October 2018

Anulekshmi Chellappan, Ramkumar, S., Akhilesh, K. V. and Santosh N. Bhendekar World Fisheries

Participations

Day organized by by Madh Daryadeep Macchimar Shakari Society Ltd. and Harbadevi Macchimar Sarvoday Sahakari Society Ltd., Madh, Mumbai, 21 November 2018

Anulekshmi Chellappan, Ramkumar, S., Akhilesh, K. V., Ajay D. Nakhawa and Santosh N. Bhendekar World Fisheries Day celebrations. Bhati Macchimar Sarvodaya Sahakari Society Ltd. Bhati, Mumbai, 23 November 2018. Bhati, Mumbai, 23 November 2018

Anulekshmi Chellappan and Ratheesh Kumar, R. Second six-monthly meeting of year 2018 of Nagar Jajbhashya Karyanvin Samiti (NARAKAS), Andheri, Mumbai, 27 November 2018

Anulekshmi Chellappan, Ajay D. Nakhawa, Santosh N. Bhendekar and Nilesh A. Pawar Meeting with Shri Sushil Kumar, IAS., Additional Secretary (DARE) & Secretary (ICAR) regarding review of ICAR institutions in Mumbai, ICAR-CIFE, Mumbai, 30 April 2019

Asha, P. S. National consultation workshop on sea cucumbers. Wildlife Institute of India, Dehradun, 03 September 2018

15th Scientific Advisory Committee (SAC) meeting, ICAR-KVK, SCAD, Thoothukudi, 29 October 2018

National Seminar on Environment Status of Estuarine and coastal Ecosystems in India. University of Kerala, Thiruvananthapuram, 14-15 March 2019

Asha, P. S. and Suja, C. P. District Level Biodiversity Committee meeting Organized by the Tamil Nadu Forest Department, Thoothukudi, 05 July 2018

Aswathy, N. Interactive session on Economics and marketing aspects of cage farming for senior officers of NABARD, ICAR-CMFRI, Kochi, 19 July 2018

Resource person for Training programme for farmers organized by the Kodungallur Taluk Primary Cooperative Agricultural and Rural Development Bank, Kodungallur, 01 August 2018

Workshop on Government sponsored schemes and establishment of farm sector enterprises for bankers organized by NABARD, Thrissur, 09 August 2018

Marketing and Network Linkages for Agri-Startups. MANAGE, Hyderabad , 10-12 September 2018

Farmer producer company (FPO) review meeting of NABARD, Kochi, 04 October 2018

State level bankers meeting organized by NABARD. Thiruvananthapuram, 16 October 2018

International training workshop on Data Analysis, CUSAT, Kochi, 21-27 January 2019

Resource person for NFDB Skill development programme for fishers. ICAR-CIFT, Kochi, 16 November 2018; 22 February 2019

Divu, D. Member, Scientific Advisory Committee of KVK, Ambuja Cement Foundation, Kodinar, Junagadh, 01 August 2018

Member, Lokvani Advisory Committee of the Community Radio Station, KVK, Ambuja Cement Foundation, Kodinar, Junagadh, 10 August 2018

State level Agriculture Mela, Gujarat organized by DGR-ICAR. Junagadh, 07-09 September 2018

Brainstorming meeting organized by Gujarat Biotechnology Research Centre on "Biotechnology intervention in Aquaculture". Gandhinagar, Gujarat, 11 September 2018

Meeting of the Negotiation committee for artificial reef module under consultancy project on "Artifical fish habitat based marine ecosystem restoration in the inshore area off Bhadresh. Veraval", Veraval, 18 September 2018

Member, Technical Committee of Gujarat Marine National Park and Marine Sanctuary Conservation Society, Ministry of Environment and Forests, Govt. of Gujarat. Jamnagar, 15 October 2018

Divu, D., Vinay Kumar Vase, Kapil S. Sukhdhane, Tarachand Kumawat, Rajan Kumar, Shikha Rahangdale and Abdul Azeez, P. Fish-preneur promotion programme for fishers' welfare conducted by Veraval Regional Centre of ICAR-CIFT. Veraval, 06 April 2018

Divu, D., Vinay Kumar Vase, Kapil S. Sukhdhane, Tarachand Kumawat, Rajan Kumar, Shikha Rahangdale and Abdul Azeez, P. Harvest Mela and Tribal farmers meet on the eve of Sagar Krishi Sankalp Sammelan, Veraval, 22 May 2018

Divu, D., Vinay Kumar Vase, Kapil S. Sukhdhane, Tarachand Kumawat, Rajan Kumar, Shikha Rahangdale and Abdul Azeez, P. Field day conducted by ICAR-CMFRI at Sidi Adivasi tribal village, Jambur, 23 May 2018

Divu, D., Kapil S. Sukhdhane and Suresh Kumar Mojjada 8th Agri Asia-Asia Prime Exhibition on Agriculture Technology, Mahtma Mandir, Gandhinagar, 07–09 September 2018

Divu, D., Vinay Kumar Vase, Kapil S. Sukhdhane, Tarachand Kumawat, Rajan Kumar, Shikha Rahangdale and Abdul Azeez, P. "Swacchta Hi Seva" programme on theme plastic pollution, personal hygiene and health under Swachh Bharat Mission. Veraval, 15 September–02 October 2018

Divu, D., Vinay Kumar Vase, Kapil S. Sukhdhane, Tarachand Kumawat, Rajan Kumar, Shikha Rahangdale and Abdul Azeez, P. Stakeholder workshop on Best Practices for Trawl Fishery in India, Veraval Regional Centre of ICAR-CMFRI, Veraval, 23-24 October 2018

Divu, D., Vinay Kumar Vase, Kapil S. Sukhdhane, Tarachand Kumawat, Rajan Kumar, Santosh N. Bhendekar, Shikha Rahangdale and Abdul Azeez, P. Abdul Azeez, P., Divu, D., Kapil S. Sukhdhane, Rajan Kumar, Shikha Rahangdale, Tarachand Kumawat and Vinay Kumar Vase Stakeholder meet on "Draft National Policy on Mariculture (NPM), 2018" for the North-west coast of India. Veraval Regional Centre of ICAR-CMFRI, Veraval, 27 November 2018

Jagadis, I. Meeting on Skill ideals fraction for processing work–Pradhan Mantri Kaushal Vikas Yojana (RPL-PMKVY) organized by MPEDA. Thoothukudi, 12 November 2018

Meeting of Board of Studies in Marine Biology. Annamalai University, Parangipetai, 30 January 2019

Jagadis, I. and Ranjith, L. Doctoral Committee meeting. Manonmaniam Sundaranar University campus, Tirunelveli, 03 January 2019

Jagadis, I., Ranjith, L. and Rajkumar, M. Consultation meeting on Marine Stewardship Council (MSC) certification for green tiger prawn, *Penaeus semisulcatus,* Thoothukudi, 03 May 2018

Jasmin, F. Scientist-in-charge. Exhibition Committee in the Visakhapatnam Hindi Parliamentary Committee meeting, Visakhapatnam, 07-09 September 2018

National Fish farmers meet and exhibition conducted by NFDB, Visakhapatnam Regional Centre of ICAR-CMFRI, Visakhapatnam, 21-22 November 2018

Johnson, B. Meeting convened by DAHDF to discuss on "Seaweed culture and commercialization of seaweed products" . Krishi Bhawan, New Delhi, 18 July 2018

Meeting to discuss about the prospects of seaweed cultivation in India. NITI Aayog, New Delhi, 17 October 2018

Meeting of the Research Advisory Committee to review the research projects sanctioned by Gulf of Mannar Biosphere Reserve Trust, Ramanathapuram, Tamil Nadu, 10 November 2018

India International Seaweed Expo and Summit 2019 at World Trade Centre. Mumbai, Maharashtra, 22-23 January 2019

Resource person in the Training programme on "Dissemination of Innovative Technology entitled Seaweed cultivation for coastal women Self Help Group" organized by Pasumpon Thiru Muthuramalin. Kamuthi, Ramanathapuram, 23 February 2019

Meeting of the Scientific Advisory Committee . KVK, Ramanathapuram, 06 March 2019

Johnson, B. and Mohammed Koya, K. Consultation on "Action Plan for Fisheries Development in Andaman & Nicobar Islands". Port Blair, 06 September 2018

Participations

Kalidas, C. and Linga Prabu, D. NADP funded project sea cage farmed Lobster harvest Mela . Sippikulam, Thoothukudi, 09 May 2018

Kalidas, C. and Ranjith, L. Stakeholders meeting, Joint Director of Fisheries, Thoothukudi, 23 October 2018

Kalidas, C., Linga Prabu, D. and Kavitha, M. International seminar on Biodiversity and conservation. Fisheries College and Research Institute, Thoothukudi, 19-20 June 2018

Kapil S. Sukhdhane 15th Meeting of Animal Science and Fisheries Science subcommittee of AGRESCO at Junagadh Agriculture University, Junagadh, 12-13 February 2019

Kripa, V. Interface meet on "Envisioning the institutionalization of ONE HEALTH for combating emerging public health threats in Kerala (Towards development of One Health Governance in Kerala), Nedumbasery, Kerala, 26-27 September 2018

Indo-UK round table on "Mitigating the socio-economic impact of marine litter". New Delhi, 12 February 2019

Lead Speaker, International Conference on Benthos (ICB9), Kochi, 14-16 March, 2019

Lead Speaker, National Conference on Marine Debris Kochi, 11 April 2018

Lakshmi Pillai, S. Stakeholder meeting on MSC certification. SEEAI, Kochi, 28 August 2018

Laxmilatha, P. Meeting with Director of Fisheries Puducherry, to discuss the proposal and methodology for implementation of bivalve farming in the coastal waters of Puducherry and Karaikal, Fisheries Directorate, Puducherry, 26 April 2018

Review meeting of bivalve farming activities with DoF to monitor the progress of the bivalve farming activities implemented in Tiruvallur and Kancheepuram districts, Directorate of Fisheries, Chennai, 17 May 2018

Meeting with Director of Fisheries, Puducherry in connection with the project proposal on mussel/ oyster culture in the waters of Puducherry. Directorate of Fisheries, Puducherry, 19 May 2018

Meeting of the State Level Approval and Monitoring Committee to evaluate and recommend a viable proposal under Centrally Sponsored Schemes on Blue Revolution for 2018-19 for NFDB. Animal Husbandry, Dairying and Fisheries Department, Govt. of Tamil Nadu, Chennai, 20 June 2018

Special lecture on "Achieving goal 2 of Sustainable Development Goals – Zero Hunger" by Mr. Carlos GARCIA Domingues, Secretary, Department of Finance, Philippines, at MSSRF, Chennai, 28 June 2018

Meeting to discuss the skill development training programmes proposed to be jointly imparted by the Tamil Nadu Skill Development Corporation to marine and inland fishermen/ fisherwomen. Department of Fisheries, Chennai, 18 August 2018

Laxmilatha, P. and Sivadas, M. Seminar on 'Climate change and sustainable development'. MSSRF, Chennai, 27 June 2018

Seminar on 'King tuna: Indian Ocean Trade, Offshore Fishing and Coral Reef Resilience in the Maldives Archipelago'. MSSRF, Chennai, 04 January 2019

Laxmilatha, P. and Mohammed Koya, K. Workshop on Knowledge in Co-Management of Tuna Fisheries in Southern India. BoBP-IGO, Chennai, 29 June 2018

Laxmilatha, P., Manojkumar, P. P., Jayakumar, R., Johnson, B. and Kalidas, C. State Level Kisan Samriddhi Mela – 2018 organised by ICAR- SBI, Coimbatore, 24–26 August 2018

Linga Prabu, D. CAFT training on Computational and Statistical advances for analysis of Biological Data in Agriculture. ICAR-IASRI, New Delhi, 23 March–24 April 2018

State level Steering Committee Meeting for the Conservation and Management of Mangroves, Wetlands and Coral Reefs . Tamil Nadu Forest Department, Chennai, 12 July 2018

Stakeholder meeting to fix standards for dry fish packaging. Indian Institute of Packaging, Perungudi, Chennai, 13 July 2018

Linga Prabu, D. and Diwakar, K. TOLIC meeting. VOC Port Trust, Thoothukudi, 29 May 2018

Maheswarudu, G., Dineshbabu, A. P., Lakshmi Pillai, S., Sarada, P. T., Saleela, K. N., Rekha Devi, Gyanranjan Dash, Ratheeshkumar, R., Rajan Kumar and Rajkumar, M. Workshop on "Fortification of knowledge base on methodologies, under the project "Implications of Recruitment Dynamics and Spatio-temporal Stock Assessment of Marine Prawns of India for fisheries management". Madras RC of ICAR-CMFRI, Chennai, 06-10 August 2018

Maheswarudu, G. and Rekha Devi Chakraborty MSC meeting and Pre-assessment process of Deepsea shrimps, *Heterocarpus chani* and *H. woodmasoni* followed by a visit to landing centres at Kollam, Kochi, Kerala, 27-30 November 2018

Manojkumar, P. P. Hindi Seminar, VOC Port Trust, Thoothukudi, 20 June 2018

Manojkumar, P. P. Jagadis, I. and Kalidas, C. Climate literacy campaign with focus on water conservation, organized by NABARD. Thoothukudi, 02 August 2018

Manojkumar, P. P. and Ranjith, L. 4th Phase of District level Co-management committee meeting under FIMSUL-II organized by Assistant Director of Fisheries, Department of Fisheries, Tamil Nadu. Nagercoil, 30 November 2018

Manojkumar, P. P. and Ranjith, L. Fishing Harbour Management Committee meeting. Thoothukudi, 23 January 2019

Margaret Muthurathinam, A. and Shoba Joe Kizhakudan Consultative Stakeholders Meet on National Mariculture Policy, Madras RC of ICAR-CMFRI, Chennai, 03 December 2018

Margaret Muthurathinam, A. and Ranjith, L. Workshop on "Enhancing precision of species level estimation of marine fish landings" under FIMSUL-II. Madras RC of ICAR-CMFRI, Chennai, 13- 15 November 2018

Mohammed Koya, K. Workshop on Network Mapping of Tuna Value Chain. Bay of Bengal Programme, (BoBP), Chennai, 28 June 2018

Knowledge in Co-Management of Tuna Fisheries in Southern India. Bay of Bengal Programme (BoBP), Chennai, 29 June 2018

Consultation with the International Affairs and Seafood Inspection Officers from NOAA, USA on Seafood Import Monitoring Programme (SIMP). MPEDA, Kochi, 17 September 2018

High Level Meeting with the visiting Vietnamese official Delegation. NFDB, Hyderabad, 20 December 2018

Muktha, M. and Jasmin, F. FRAD Zonal workshop-cum-training on data collection, Visakhapatnam Regional Centre of ICAR-CMFRI, Visakhapatnam, 16-19 July 2018

Nilesh A. Pawar Panelist in "Conserving Our Oceans from Plastic Pollution" organized by The U. S. Consulate General, Mumbai and Sustainability Nexus on the occasion of World Oceans Day. Bandra Kurla Complex, Mumbai, 08 June 2018

Pralaya Ranjan Behera Fish Festival. YMCA, Visakhapatnam, 10 July 2018

Andhra Pradesh State Biodiversity Board meeting. Guntur, 18 July 2018

Protocol officer to the Honorable members of the Parliamentary Committee during visit of the Second Sub Committee of the Committee of Parliament on Official Language to Visakhapatnam Regional Centre of ICAR-CMFRI, Visakhapatnam, 07-09 September 2018

Workshop on on strategy and action plan for 2019-2029. Andhra Pradesh State Biodiversity Board, Vijayawada, 30 January 2019

Meeting on Conservation of Olive Ridley Turtle. Department of Forests, Visakhapatnam, 15 February 2019

Participations

Prema, D. Nirmala Dhara Workshop for Blue Green Brigade Volunteers. ICAR-CMFRI, Kochi, 25 July 2018

Rajan Kumar Short course on "Advance statistical methods and computational software for fisheries researchers. ICAR-CIFT, Kochi, 17-26 July 2018

Rajkumar, M. Training on responsible fishing and management in marine capture fisheries, organised by the State Fisheries Department and International Fund for Agricultural Development. Thondi and Soliyakudi, Ramanathapuram, 27-28 June 2018

Meeting with Tamil Nadu State Fisheries Department officials for the Fishery improvement project on flower shrimp *Penaeus semisulcatus*. Ramanathapuram, 08 October 2018

Raju, S. S. Sea food import monitoring programme (SIMP). Visakhapatnam Regional Centre of ICAR-CMFRI, Visakhapatnam, 10 October 2018

Raju, S. S., Biji Xavier, Johnson, B., Muktha, M. and Jasmin, F. Brainstorming session on seaweed resources and its culture potential in Andhra Pradesh . Visakhapatnam Regional Centre of ICAR-CMFRI, Visakhapatnam, 21-22 June 2018

Raju, S. S., Biji Xavier and Pralaya Ranjan Behera Workshop on Indo-UK collaborative project on Diognosis for one health and user driven solution for AMR (DOSA). Visakhapatnam Regional Centre of ICAR-CIFT, Visakhapatnam, 20 September 2018

Ramkumar, S., Ajay D. Nakhawa, and Santosh N. Bhendekar Inter-agency coordination meeting to combat illegal wildlife trade, Mangrove Foundation. Mumbai, 17 September 2018

Meeting with officials of Directorate of Revenue Intelligence (DRI), Marine Lines, Mumbai regarding illegal wildlife trade and shark fin identification support. Mumbai, 18 September 2018

Meeting of the National Committee for the International Indian Ocean Expedition 2 (IIOE-2), Ministry of Earth Sciences, New Delhi, 30 January 2019

WWF-CMFRI-CIFT workshop on Management of Sharks of Gujarat. Veraval, 28-29 March 2019

Ranjith, L. Training programme on Discovery and use of operational Ocean data Product and Services. Ocean Teacher Global Academy, INCOIS, Hyderabad, 18 – 22 June 2018

National workshop on Rapid Response Plan for the Management of Coral Reef Ecosystems of India by GEF-UNDP-GOI NATCOM project. Thoothukudi, 23–24 August 2018

Training on the Seafood Import Monitoring Program (SIMP) on IUU fishing. MPEDA, Thoothukudi ,11 October 2018

Workshop on "Integration of square mesh cod end in trawling to reduce bycatch in fishing operation" . Thoothukudi, 07 March 2019

Ratheesh Kumar, R. 28th Swadeshi Science Congress themed "Science for Nation" CSIR-NIIST, Thiruvananthapuram , 07-09 November 2018

Rekha Devi Chakraborty Pre-thesis submission colloquium of Ph. D scholar, Mangalore University, Mangaluru, 28 June 2018, 07 December 2018

Reshma Gills Farmer-Scientist interaction meet with Members of SHG led Clam processing units. Vaikom, 21 September 2018

Farmer-Scientist interaction meet with Aquaponics Unit members. Kadungalloor and Paravoor, 04 October 2018

Farmer-Scientist interaction meet on Integrated Farming Systems. Vazhakala and Karumalur, 27 October 2018

Farmer- Scientist interaction meet with Aquaculture SHGs. Mookkannoor, Ernakulam, 16 November 2018

Farmer-Scientist interaction meet with Ornamental Fishery SHGs. Keezhillam, Perumbavoor, 24 January 2019

Farmer- Scientist interaction meet with Chinese Dip Net Units. Thanneermukkam, Vaikom, 19 February 2019

Ritesh Ranjan Workshop on "Norwegian technology for land-based RAS and krill: an important ingredient for fish and shrimp feed". Chennai, 19 September 2018

Scrutiny and evaluation of the expression of interest (EOI) for Technology transfer for seed production of marine finfish (orange spotted grouper and Indian pompano). NFDB, Hyderabad, 25 February 2019

Sakthivel, M. 1st National Congress on Genetics. New Delhi, 14-16 December 2018

International workshop on "Genomic Selection in Aquaculture". Mumbai, 16-18 January 2019

Santosh N. Bhendekar Discussion on New CRZ 2018 and Destructive fishing organized by National Fishworkers Forum (NFF) and Maharashtra Macchimar Kruti Samiti. Mumbai, 02 May 2018

7th and 8th Sub-Committee for Threatened Plant/Animal Species in the state. Maharashtra State Biodiversity Board, Pune, 11–14 August 2018

Aquascaping meet with Commissioner of Fisheries, Government of Maharashtra and Fisheries Department officials. Taraporewala Aquarium, Mumbai, 04 October 2018

International Conference on Challenges and Opportunities for Sustainable Fisheries and Aquaculture Development (COSFAD2019). Ratnagiri, 17-20 January 2019

Saravanan Raju International workshop on "Gobioid Fishes". Kanyakumari, 10-11 August 2018

National workshop on "Rapid Response Plan (RRP) for Managing Coaral Reef ecosystems of India to mitigate threats of coral bleaching and disease outbreak". Thoothukudi, 23-24 August 2018

Shelton Padua Interactive map–a medium for creating awareness about litter status of Indian beaches. Kochi, 11-12 April 2018

LENFEST-CSIRO Workshop on Benchmarks for Ecosystem Assessment: Indicators and Guidelines for Practical Ecosystem Based Fishery Management. CMFRI, Kochi, 24-28 September 2018

Shikha Rahangdale Winter School on "Recent advances in Fishery biology techniques for biodiversity evaluation and conservation" ICAR-CMFRI, Kochi, 01-21 December 2018

Shinoj Parappurath Meeting on 'Impact of rainfall induced natural calamity on agriculture and allied sectors. KAB-II, New Delhi, 08 October 2018

Lecture on "Farm Business Planning and Budgeting for Small-scale Fishery Enterprises" KVK, Ernakulam, 26 November 2018, 20 December 2018

Meeting to formulate fisheries insurance schemes in aquaculture, capture fisheries and mariculture. held at NFDB, Hyderabad, 01 February 2019

Shoba Joe Kizhakudan National Workshop for preparing the National Plan of Action for IUU fishing in India jointly organized by the DADF and the BOBP-IGO. Chennai, 23-24 April 2018

Interface Meeting with Developmental Departments organized by ICAR-CRIDA. Chennai, 25 May 2018

Resource person in the Capacity Building Course (CBC) on "Sustainable Development Goal -14 conducted by the BOBP-IGO for Officials of the Government of Sri Lanka. Chennai, 26 November–05 December 2018

Shubhadeep Ghosh ICAR Regional Committee meeting. Bhubaneswar, 22–23 June 2018

Board Meeting of the Andhra Pradesh State Biodiversity Board. Vijayawada, 24 January 2019

Meeting on "Developing a roadmap for development of mariculture and marine capture fisheries in Andaman and Nicobar Islands". Port Blair, 28 January–01 February 2019

Stakeholder Consultation for Setting up of NBC for *Penaeus vannamei*. Visakhapatnam, 08 February 2019

Participations

Shubhadeep Ghosh and Biji Xavier Writeshop on "Tropical marine finfish breeding and seed production". Visakhapatnam Research Centre of ICAR-CMFRI, Visakhapatnam, 14-17 August 2018

Shubhadeep Ghosh, Raju, S. S., Biji Xavier, Jasmin, F. and Pralaya Ranjan Behera Stakeholder consultation on Draft National Policy on Mariculture (NPM2018). Visakhapatnam Regional Centre of ICAR-CMFRI, Visakhapatnam, 14 November 2018

Shubhadeep Ghosh, Manas, H. M. and Muktha, M. Stakeholder Consultations for Project Preparation Grant of BOBLME. Visakhapatnam, 01 March 2019

Shyam S. Salim Project Monitoring and Review Committee Meeting (OSF & MFAS). INCOIS, Hyderabad, 06 April 2018

3rd International Symposium on Aquaculture and Fisheries Education (ISAFE 3)–a triennial event of the Asian Fisheries Society (AFS). ICAR-CIFE, Mumbai, 16-18 May 2018

Stakeholder meeting on One Planet City Challenge (OPCC). Kochi, 08 June 2018

Training workshop on "Ecosystem Assessment and Fisheries Modelling". ICAR-CMFRI , Kochi, 24-28 September 2018

Meeting of the Theeramythri Group members Family Meet. Thiruvananthapuram, 16 November 2018

TOLIC Official Language Seminar. Hindustan Petroleum Corporation Ltd (HPCL). Kochi, 04 January 2019

National Seminar on 'Maritime Security of India: Challenges and Policy Options'. University of Kerala, 29–31 January 2019

World Wetland Day Celebration – 2019 themed "Multidisciplinary Dialogue on Impact of Climate Change on Wetland Fisheries". Department of Aquatic Biology and Fisheries, Thiruvananthapuram, 14 February 2019

Shyam S. Salim, Raju, S. S., Ritesh Ranjan, Biji Xavier, Muktha M., Jasmin, F. and Manas, H. M. Second World Ocean Science Congress 2019 (WOSC-2019), Andhra University, Visakhapatnam, 25-27 February 2019

Singh, V. V. Divisional Committee meeting of Fishery Survey of India. Mumbai, 23 July 2018

125th Meeting of Maharashtra Coastal Zone Management Authority. Mumbai, 20 August 2018

Singh, V. V., Anulekshmi Chellappan, Ramkumar, S., Ratheesh Kumar, R., Akhilesh, K. V., Ajay D. Nakhawa and Santosh N. Bhendekar International Symposium on Aquaculture and Fisheries Education. ICAR-CIFE, Mumbai, 16-18 May 2018

Singh, V. V., Ramkumar, S., Ratheesh Kumar, R., Akhilesh , K. V., Ajay D. Nakhawa and Santosh N. Bhendekar Coastal Regulation Zone (CRZ)–2018 Workshop organised by National Fish Workers Forum and Maharashtra Macchimar Kruti Samiti. ICAR-CIFE, Mumbai, 21 May 2018

Singh, V. V., Anulekshmi Chellappan, Ramkumar, S. and Ajay D. Nakhawa Meeting with Shri. Anoop Kumar, IAS, Principal Secretary (A. D. F), Govt. of Maharashtra, Shri. Arun Vidhale, IAS, Commissioner of Fisheries, Govt. of Maharashtra and Shri. Rajendra Jadhav, Joint Commissioner. Mumbai RC of ICAR-CMFRI, 06 September 2018

Sivadas, M. Regional Co-Management Committee meeting for Coromandel Coast. Department of Fisheries (Regional), Chennai, 21 August 2018

Sivadas, M., Margaret Muthurathinam, A., Shoba Joe Kizhakudan and Chhandaprajnadarsini, E. M. Stakeholders' meet under the project "Resource Assessment and Management framework for sustainable Marine Fisheries of Tamil Nadu and Puducherry". Chennai, 18 July 2018

Sivadas, M. and Shinoj Parappurath Meeting on "Methodologies for Conducting Fishing Fleet Techno-Economic Performance Review". Chennai,Tamil Nadu, 18-20 September 2018

Sivadas, M., Manojkumar, P. P., Shoba Joe Kizhakudan, Margaret Muthurathinam, A., Ranjith, L., Rajkumar, M. and Chhandaprajnadarsini, E. M. FRAD zonal workshop on methodology for data collection for FRAD staff, Madras Research Centre of ICAR-CMFRI, Chennai, 25-28 September 2018

Srinivasa Raghavan, V. Hands-on training on "Aquaculture Genomics and Bioinformatics". ICAR-CIBA, Chennai, 7 August–01 September 2018

Workshop on "Knowledge Management in Marine Fisheries Sector". BOBP-IGO, Chennai, 12 October 2018

Suja, C. P. Workshop on "3D Bio printing". Vellore Institute of Technology (VIT), Vellore , 17 October 2018

Research Advisory Committee Meeting of Manonmaniam Sundaranar University. Abishekapatti, Tirunelveli, 30 November 2018

Swathi Lekshmi, P. S. 9th meeting of Project Appraisal and Monitoring Committee (PAMC) on Ocean Science and Resources. INCOIS, Hyderabad, 11-12 January 2018

Discussion on SDG-14 (Goal-14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development), convened by the Department of Planning & Economic Affairs (CPMU), Thiruvananthapuram, 20 April 2018

Expert Committee Meeting, NASF. NASC Complex, Pusa, New Delhi, 16 May 2018

National Workshop on "Small-scale Fisheries, Cyclone Ockhi and Disaster Risk Manaagement". International Collective in Support of Fish Workers, Thiruvananthapuram, 29-30 May 2018

Stakeholders workshop. Vizhinjam Research Centre of ICAR-CMFRI, Vizhinjam, 31 May 2018

Resource Personnel for Entreprenurship Programme at KITCO. Thiruvananthapuram, 13 December 2018

Tarachand Kumawat Workshop on "Applications of Satellite Altimetry for Inland Waterbodies". Indian Institute of Remote Sensing, Dehradun, 30 May 2018

National Natural Resource Management System (NNRMS) Certificate Course on "Remote Sensing (RS) and Geographical Information System (GIS)". Dehradun, 01 May–22 June 2018

Delivered talk on "Overview of Whale Shark, it's habitat, distribution, biology and conservation status" on the occasion of the "Whale Shark Day Celebration 2018". 07 December 2018

Delivered talk on "Marine Protected Areas: Goodwill for Marine Life" on the occasion of the National Science Day. Simar, Veraval, 28 February 2019

Discussion on "Responsible Marine Fisheries: Role of threatened species conservation in India" on the occasion of the World Wildlife Day Celebration. Gandhinagar, Gujarat, 03 March 2019

Vinay Kumar Vase FRAD Zonal workshop for North-west coast. Mumbai RC of ICAR-CMFRI, 30 July–02 August 2018

Vinothkumar, R. Awareness campaign on "Codes and regulation of fishing practices at district level" organised by the Tamil Nadu State Fisheries Department. Thiruppalaikudi, Ramanathapuram District, 29 June 2018

Invited talk on "Importance of Co-Management in the marine Fisheries Sector" during the occasion of Gandhi Jayanti Celebration organised by Tamil Nadu State Fisheries Department. Vedalai, Ramanathapuram District, 02 October 2018

Zacharia, P. U. Sixth Annual Review meeting of NICRA Project. NASC complex, New Delhi, 06-09 August 2018

Meeting with officials of Himachal Pradesh State Fisheries Department . Bilaspur, 04-07 February 2019

Invited lecture on "Decadal trends of Indian demersal fisheries" during International Conference on Benthos. CUSAT, Kochi, 06–08 March 2019

Participations

Zacharia, P. U., Mohamed, K. S., Kripa, V., Maheswarudu, G., Sathianandan, T. V., Narayanakumar, R., Joshi, K. K., Imelda Joseph, Vijayagopal, P., Kaladharan, P., Josileen Jose, Sobhana, K. S., Molly Varghese, Jayasankar, J., Prema, D., Lakshmi Pillai, Sanil, N. K., Somy Kuriakose, Rekha J. Nair Vipinkumar, V. P., Krupesha Sharma, Shyam S. Salim, Miriam Paul Sreeeam, Mini, K. G., Jeyabaskaran, R., Aswathy, N., Rekha Devi Chakraborty, Grinson George, Sandhya Sukumaran, Venkatesan, V., Shelton Padua, Mohammed Koya, K., Sreenath, K. R., Shinoj Parappurath, Eldho Varghese, Vivekanand Bharti, Sanal Ebeneezar, Jeena, N. S., Reshma, K. J., Sumithra, T. G., Vidya, R., Divu, D., Vinaya Kumar Vase, Abdul Azeez, P., Rajan Kumar, Tarachand Kumawat, Singh, V. V., Kapil S. Sukhdhane, Akhilesh, K. V., Ramkumar, S., Ratheesh Kumar, R., Ajay D. Nakhava, Santhosh N. Bhendekar, Nilesh A. Pawar, Prathibha Rohit, Bindu Sulochanan, Divya Viswambharan, Asokan, P. K., Anil, M. K., Swathi Lekshmi, P. S., Vinod, K. , Manojkumar, P. P., Asha, P. S., Ranjith, L., Abdul Nazar, A. K., Jayakumar, R., Johnson, B., Saravanan Raju, Remya Abhijith, Thirumalaiselvan, M., Laxmilatha, P., Sivadas, M., Joe K. Kizhakudan, Muktha, M. and Subal Kumar Roul National Conference on Marine Debris (COMAD 2018), Marine Biological Association of India, ICAR-CMFRI, Kochi, India, 11-12 April 2018

Zacharia, P. U., Manojkumar, P. P., Shoba Joe Kizhakudan, Sujitha Thomas, Akhilesh, K. V., Muktha, M., Remya, L. and Shikha Rahangdale CITES Non-Detriment Findings Workshop for Thresher and Silky Sharks jointly organized by Blue Resources Trust, Sri Lanka and ICAR-CMFRI, Kochi, 16-20 April 2018

Zacharia, P. U. and Shyam S. Salim Stakeholder consultation to discuss the salient findings of the institute funded project "Resource Assessment and Management Framework for Sustainable Marine Fisheries of Kerala". ICAR-CMFRI, Kochi, 01 June 2018

Zacharia, P. U. and Sandhya Sukumaran Interactive meeting on "Initiating collaborative research on Climate Change and Food Security". Kerala Veterinary and Animal Sciences University, Pookode, 25 July 2018

Zacharia, P. U., Mohamed, K. S., Maheswarudu, G., Sathianandan, T. V., Josileen, Jose, Lakshmi Pillai, Ganga, U., Najimudeen, T. M., Rekha Devi Chakraborty, Sujitha Thomas, Geetha Sasikumar, Mini, K. G., Somy Kuriakose, Rajesh, K. M., Eldho Varghese, Shelton Padua and Tarachand Kumawat LENFEST Training workshop on "Benchmarks for Ecosystem Assessment: Indicators and Guidelines for Practical Ecosystem Based Fishery Management" organised by CSIRO, Australia, ICAR-CMFRI, Kochi, 24-28 September 2018

Zacharia, P. U., Mohamed, K. S., Sathianandan, T. V., Maheswarudu, G., Abdussamad, E. M., Josileen Jose, Lakshmi Pillai, Najimudeen, T. M., Somy Kuriakose, Rekha J. Nair, Ganga, U., Mini, K. G., Venkatesan, V., Aswathy, N., Rekha Devi Chakraborty, Grinson George, Vidya, R., Shelton Padua, Asokan, P. K., Saleela, K. N., Mahesh, V., Surya, S., Ambarish P. Gop Methodology refinement workshop held under Kerala FMP project, ICAR-CMFRI, Kochi, 30-31 October 2018

Zacharia, P. U., Mohamed, K. S., Kripa, V., Maheswarudu, G., Jayasankar, P., Sathianandan, T. V., Narayanakumar, R., Joshi, K. K., Imelda Joseph, Vijayagopal, P., Kaladharan, P., Reeta Jayasankar, Abdussamad, E. M., Josileen Jose, Sobhana, K. S., Molly Varghese, Jayasankar, J., Boby Ignatius, Prema, D., Lakshmi Pillai, Sanil, N. K., Somy Kuriakose, Rekha J. Nair, Ganga, U., Vipinkumar, V. P., Shyam S. Salim, Miriam Paul Sreeeam, Mini, K. G., Jeyabaskaran, R., Najimudeen, T. M., Aswathy, N., Rekha Devi Chakraborty, Grinson George, Sandhya Sukumaran, Venkatesan, V., Shelton Padua, Rajesh, N., Mohammed Koya, K., Sreenath, K. R., Shinoj Parappurath, Eldho Varghese, Vivekanand Bharti, Sanal Ebeneezar, Jeena, N. S., Reshma, K. J., Sumithra, T. G., Vidya, R., Rehma Gills, Sivadas, M. and Shubhadeep Ghosh South Indian Fisheries Ministers' Meet organized by ICAR-CMFRI in collaboration with Department of Fisheries, Kerala State. Kochi, 10-11 November 2018

Zacharia, P. U. and Mohamed, K. S. Stakeholder workshop on MSC certification. Kochi, 10 December 2018

Zacharia, P. U., Mohamed, K. S., Sathianandan, T. V., Maheswarudu, G., Josileen Jose, Dineshbabu, A. P., Lakshmi Pillai, Sarada, P. T., Ganga, U., Rekah J. Nair,Najimudeen, T. M., Somy Kuriakose, Mini, K. G., Venkatesan, V., Rekha Devi Chakraborty, Grinson George, Vivekanand Bharti, Livi Wilson, Gyanranjan Dash and Rajkumar, M. Workshop on Stock Assessment conducted by Dr. Paul Medley, ICAR-CMFRI, Kochi, 12-13 December 2018

Zacharia, P. U., Mohamed, K. S., Vijayagopal, P., Kaladharan, P., Laxmilatha, P ., Josileen Jose, Dineshbabu, A. P., Joe K. Kizhakudan, Geetha Sasikumar, Margaret Muthurathinam, A., Shoba Joe Kizhakudan, Shyam S. Salim, Suja, C. P., Swathi Lekshmi, P. S., Vidya Jayasanakar, Jeyabaskaran, R., Srinivasa Raghavan, V., Grinson George, Johnson, B., Kalidas, C., Sandhya Sukumaran, Sakthivel, M., Rameshkumar, P., Sankar, M., Pralaya Ranjan Behera, Jeena, N. S., Linga Prabu, D., Divya Viswambharan, D., Ratheesh Kumar, R., Santosh N. Bhendekar, Rajkumar, M., Vinothkumar, R. and Chhandaprajnadarsini, E. M. World Brackishwater Aquaculture Conference (BRAQCON 2019). ICAR-CIBA, Chennai, 23-25 January 2019

Deputation Abroad

Dr. A. Gopalakrishnan, Director

12th Asian Fisheries and Aquaculture Forum (12IFAF), Iloilo, Philippines. 08-12 April 2018

International component of Senior Executive Development Programme on "Effective Organizational Leadership" for Senior Officers of ICAR, jointly organized by ASCI and ICAR-NAARM, in Australia, New Zealand and Singapore, 19–29 May 2018

Akhilesh, K. V. International Union for Conservation of Nature (IUCN) Symposium and Red List Assessment of Sciaenids of Indian Ocean. Malaysia, 24-28 September 2018

Imelda Joseph and Aswathy, N. 12th Asian Fisheries and Aquaculture Forum (12IFAF), Iloilo, Philippines. 08-12 April 2018

Imelda Joseph, Jayasree Loka, Shubhadeep Ghosh and Ritesh Ranjan Sixth International Symposium on Cage Aquaculture in Asia 2018 (CAA6). Surat Thani, Bangkok, Thailand, 12-15 October 2018

Kripa, V. Working Goup 2 (WG2)–First Lead Authors meeting organised by the Intergovernmental Panel on Climate Change (IPCC). Durban, South Africa, 20-26 January 2019

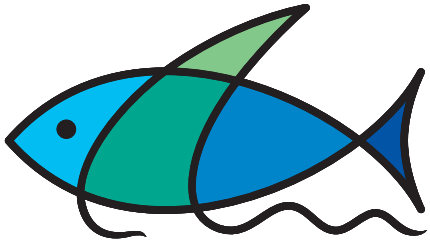
Mohammed Koya, K. Fourteenth Working Party on Ecosystem and Bycatch, Indian Ocean Tuna Commission. Cape Town, South Africa, 10-14 September 2018

Shyam S. Salim Biennial Conference on "Adapting to a Changing World: Challenges and Opportunities". International Institute of Fisheries Economics and Trade, University of Washington, Seattle, USA, 16-20 July 2018

Short Course on "Climate Change and food security nexus – Adaptation and mitigation as institutional change processes". Wageningen UR Centre for Development Innovation, Wageningen, The Netherlands, 10-21 September 2018

Sreenath, K. R. and Akhilesh, K. V. EAF-Nansen Programme on Strengthening the knowledge base for and implementing an ecosystem approach to marine fisheries in developing countries". Sponsored by FAO. Myanmar, 24 August–11 September 2018

Swathi Lekshmi, P. S. International Conference on 'Gender in Aquaculture and Fisheries: Expanding the Horizons', in GAF-7, Asian Institute of Technology (AIT), Bangkok, Thailand, 18-20 October 2018



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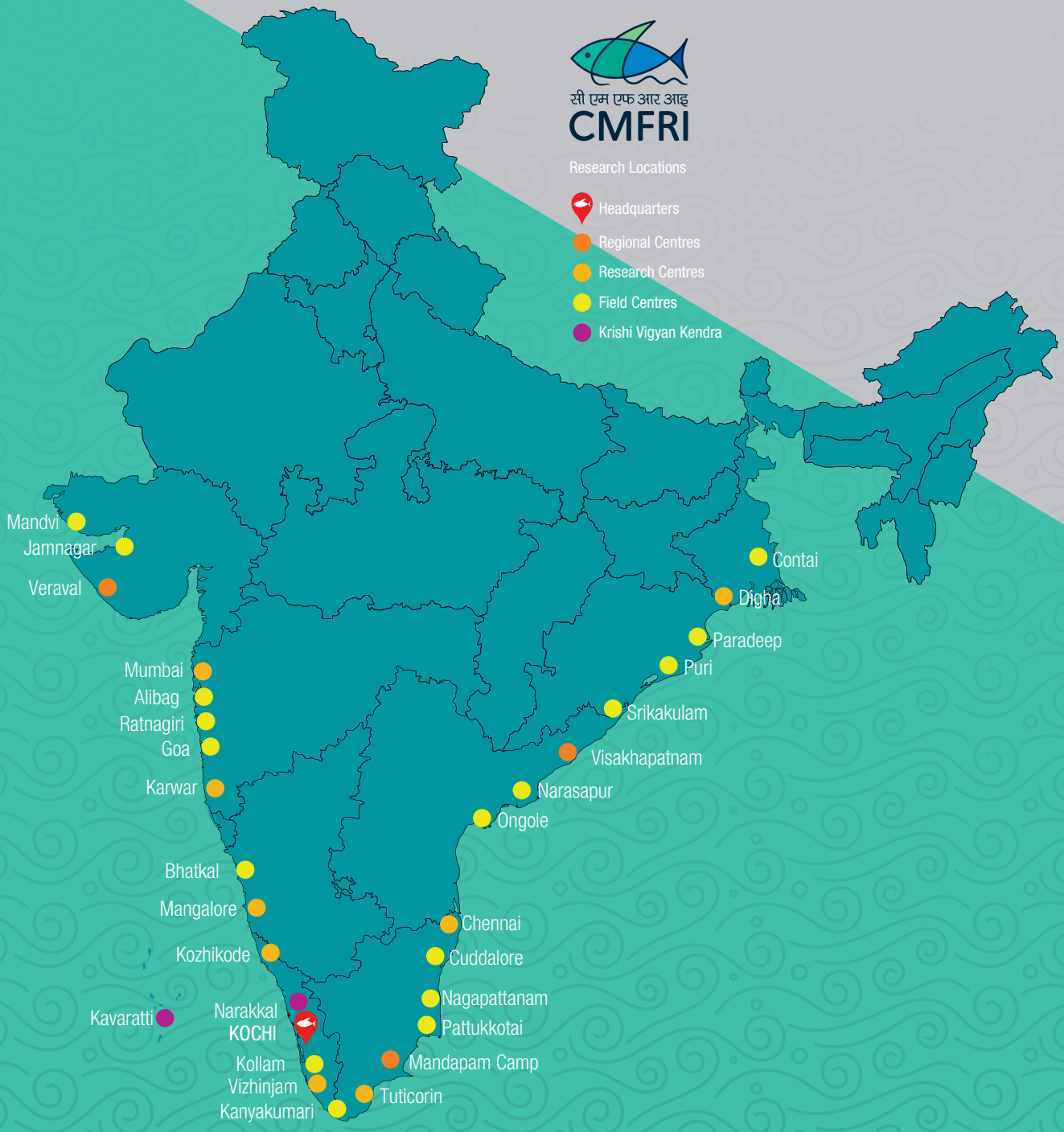

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